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Editorial:
Mysterious Meson
Inside Front Cover

25¢

SCIENCE SERVICE PUBLICATION

Mysterious Meson

➤ THE SIGNIFICANCE of the recent production of mesons, *alias* mesotrons, i the cyclotron at the University of California, is not that man has again accom plished the seemingly impossible. Such announcements are becoming commo place, in this rapidly unfolding field of new discoveries. But, with the too available, the method pioneered and the way to better results clearly pointe out, researchers in nuclear studies are now poised for the take-off into anothe unknown territory.

Up to now, mesons have been single entities, making their wavy track among non-registering atoms on photographic plates, ending their brief caree as bursting "stars." One meson now and then on plates designed to catch othe nuclear manifestations gave only tantalizing glimpses into the world within t nucleus of the atom.

Now that it has been shown that production of mesons in quantity await merely the application of greater power to the cyclotron, the production streams of mesons will be the aim of restless atom probers. Although the lif of individual pairs of mesons is a fraction of a second, the statistical result o many mesons should yield new data on the stuff of the world and how it made. When the streams of mesons can be produced at will, experimentatio on the results of their action can be begun in earnest. What these results wi be is at this moment anyone's guess.

Up to now, the classic concepts of matter and energy as essentially differen kinds of phenomena has dominated our thinking, although wherever we turn the spotlight of intensive study on any part of an atom the thing we find there whether electron or nucleus, turns out to be a form of energy. We hav stumbled upon the secret of releasing some of this energy, and in doing so have placed a new tool of destruction in the hands of the world's irresponsibles. With the mysterious meson we seem to reach the threshold of the area where the energy we thought forever lost may be recombined by some principle of cosmic conservation into matter again, to continue an unbroken cycle.

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➤ PHOTOGRAPHIC PLATES *shielded by copper are being installed in the cyclotron by Dr. Eugene Gardner, right, and Dr. C. M. G. Lattos, left, of the University of California, who succeeded in producing mesotrons artificially in quantities enormously greater than those found in cosmic rays.*

Mesons To Order

➤ EXPLANATION of the role of mesons, also known as mesotrons, in atomic rearrangements comes from a report by the United States Atomic Energy Commission, commenting on the recent production of these particles in the cyclotron at the University of California. Dr. Eugene Gardner of the Radiation Laboratory there, with Dr. Cesare M. G. Lattes of the University of Sao Paulo, Brazil, now at California on a Rockefeller Foundation fellowship, perfected the method of getting mesotrons from atomic nuclei by bombardment of suitable elements with the cyclotron's alpha particle beam at very high energies. Quantities of meson tracks were found on the photographic plates used to record the results.

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Previous study of mesons has been largely confined to fortuitous occurrence of their tracks in cosmic ray records. Dr. Lattes, before coming to California, worked with a group of scientists from the University of Bristol, England, who visited the peaks of high mountains in the Andes to study cosmic radiation.

During years of careful study and development of special techniques, the scientists at Bristol, taking their emulsions to mountain tops in the Andes and Pyrenees, were able to explain how the light meson often originated from a heavier meson.

The Bristol scientists found on their photographic emulsions mesons of a mass of about 320 times that of the electron. They found that these heavy mesons were both positively and negatively charged, and there was some evidence that neutral mesons also existed.

All of these heavy mesons were studied at very low energies, of a few million electron volts, when they were close to or undergoing disintegration. At these energies, the positively charged heavy mesons, being unable to penetrate the electrical barriers of positively charged nuclei, simply wandered through the photographic emulsion until they disintegrated, giving birth to light mesons.

However, the negatively charged heavy mesons were greedily swallowed by nuclei, resulting in the detonation of the capturing nuclei into showers of particles called "stars." At the end of their course, when nearing capture, the mesons made a wavy track. The wavy track is made because the particle is relatively light, and, at the extremely low energies involved, it takes a severe buffeting from nuclei in the emulsion.

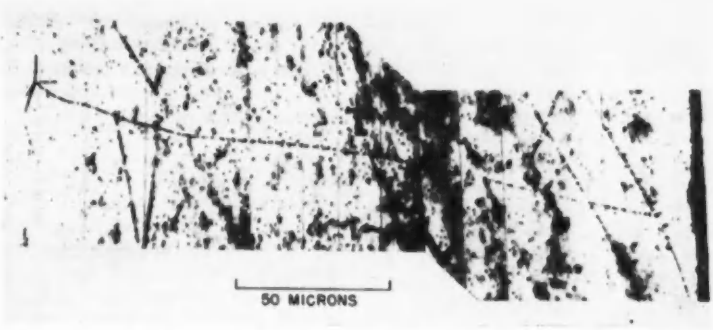
Thus the Bristol experiments explained where the light mesons originated and why they were unable to interact with nuclei.

The negative heavy mesons, now known as a result of the Berkeley research to have a mass of 313, are the type which have been produced in the giant Berkeley cyclotron. The characteristic wavy track and the "stars" resulting from the detonation of nuclei are also observed. About half the meson tracks observed end in "stars."

The mesons were made by placing targets of carbon, beryllium, copper or uranium in front of the alpha particle beam. The negative heavy mesons emitted as a result of nuclear collisions are deflected out by the cyclotron's magnetic field, in a semi-circle away from the regular path of the positively charged alpha particles in the magnetic field.

With protective strips of copper on three sides to keep neutrons and other particles from entering the emulsion, the mesons are nicely separated from other radiations which would otherwise tend to obscure the newly observed phenomena. This experimental arrangement was devised by Dr. Edwin M. McMillan, Professor of Physics. Dr. Robert R. Serber, in charge of theoretical work in the Radiation Laboratory, joined in interpretation of the results.

Drs. Gardner, Lattes and Serber explained that mesons are actually produced by an intricate sub-nuclear process, which can occur at the peak energy of the giant cyclotron only a small percentage of the time in a



➤ WAVY LINE *ending in a star is the signal of a mesotron. This is one of the impressions which Dr. Gardner and Dr. Lattos found on the plates they exposed to high energy radiation. They hope to try the effect of even higher energies on the nucleus of the atom.*

given number of collisions. The explanation is something as follows:

An alpha particle is composed of four particles—two neutrons and two protons. On the average, each of these four particles has one-fourth of the 380 million electron volts which the cyclotron gives to the alpha particle, just as the total energy of a fast traveling train is divided up among its engine and different cars.

This equal division of energy is just an average over a given period of time. At times, the engine, or one or more of the cars, by the interaction of forces between all the parts, receives more than its share of available energy.

The same thing, in a very rough sense, occurs in the alpha particle. Therefore, sometimes when an alpha particle crashes into its target, one of the protons or neutrons has a great deal more than its average one-fourth share of the total 380 million electron volts. A small percentage of the time one particle will have as much as 225 million electron volts.

The particles in target nuclei are actually always in motion inside these nuclei. If a proton in a target nucleus happens to be moving toward a bombarding 225 million electron volt proton from the alpha particle at the time of a collision, there is a compounding of energy, the total of which is about 390 million electron volts, just sufficient for the release of mesons.

When two such protons meet head-on one of the protons is converted, by nuclear exchange forces operating at the time of collision, into a neutron and a negative meson.

The observed mesons have an energy of only about four million electron volts, an extremely low energy for a meson. The mesons travel about nine inches in a vacuum between their origin in the target and their destination in the photographic emulsion.

The emulsions are about two-thousandths of an inch thick. They

are very much like those of ordinary fine-grained photographic plates but considerably thicker. Stacks of about six emulsion plates are placed edgewise to the path of the mesons for 10 minutes. The mesons make a track about four one-hundredths of an inch long the track being made by electrons knocked off of nuclei in the emulsions. Scientists place the developed emulsions under a 600-power microscope in order to bring the tracks into view.

Dr. Serber said that theoretical calculations have indicated that the mesons were being made from the beginning of operation of the big cyclotron over a year ago. However, since barely enough energy was available and the percentage of meson-producing hits was so small, it was considered a strong possibility that mesons might not be observed at all until an even more powerful atom-smasher was built.

However, the compounding of the techniques developed by Drs. Gardner and Lattes permitted the observation of meson tracks on the first plates exposed in the cyclotron bombardments.

Dr. Lattes said that in British experiments with nature as a laboratory, eight people work a year to get 100 negative meson tracks. At the University of California, one person has observed 27 tracks in 10 minutes of observation.

The first plate exposed by Drs. Lattes and Gardner, for a period of thirty seconds, yielded 100 times as many mesons per plate as were obtained in the Andes in 45 days. Thus ten million times as many mesons per second were detected in the cyclotron as on a mountain top.

Improvements have been made in the technique during the few days since the first mesons were obtained. On the first night, one track in 10,000 was a meson; with improvements, one track in 10 is a meson.

The scientists have placed emulsions inside the cyclotron, where they believe positive heavy mesons, decaying into light mesons, are being made, but so far none has been observed, primarily because of the heavy radiation inside the chamber which obscures the elusive tracks of mesons on emulsions. With the development of new methods, the positive mesons are expected to be found. A positive meson would be created from the collision of two neutrons at these high energies.

Dr. Serber cited the following significant implications in connection with meson production:

1. It proves the idea is right that there is an intimate connection between nuclear particles and mesons and between nuclear forces and mesons.

2. With the means now provided to create and observe mesons under controlled conditions in the laboratory, it may be possible to determine what are the ultimate particles of matter, why only these particles exist, and what their properties are. Dr. Serber said, for example, that it is now a simple matter to determine the masses of the mesons, which was of some uncertainty. The mass can be calculated by the radius of its flight in a magnetic field from target to emulsion and the range of its penetration into the emulsion.

3. The study of mesons will be par-

ticularly important in determining the nature of the sub-atomic force which holds nuclei together, a force unlike any other known to man.

4. Techniques will probably be developed, in time, which will enable scientists to study mesons as thoroughly as neutrons and protons. Such techniques would entail the use of specialized Geiger counters.

New "Trigger" For Bomb Suggested

➤ ENERGY MAY BE blasted out of the atom by a lighter weight particle than the prime "trigger" of the atomic bomb, the neutron.

The thoughts of scientists attending the American Physical Society meeting in New York recently turned toward the meson, alias mesotron, the fundamental particle of matter which has just been artificially produced. It is generated in nature by powerful cosmic rays entering the earth's outer atmosphere with tremendous energies.

Dr. John A. Wheeler, the young Princeton University physicist specializing on the structure of the atom, has figured out that the most familiar sort of meson (there are probably four or five kinds of them) will produce fission of uranium. It is reasonably probable that it will split asunder the hearts of other heavy atoms with release of energy, that is, the turning of mass into energy, which is what happens in the fission of uranium or plutonium by neutrons (the process of the atomic bomb).

This is a very exciting idea, and one that may be upsetting even to the international balance of atomic power. If the meson is created under control and aimed at materials that it can fission, it may be necessary to bring other elements than uranium and thorium under control of national and international atomic energy commissions.

Of course, we are a long way from a meson atomic bomb or atomic power plant. The experimental demonstration of meson fission has not yet been made. We are at an earlier stage in the possible realization of meson fission than the world was in 1939 when neutron fission of uranium was demonstrated in Germany.

The least that has happened on this new atomic frontier is that, as Dr. Wheeler says, "experimental and theoretical studies of the interaction of negatively charged mesons with atomic nuclei furnish another point of advance on the elementary particle problem."

What seems to happen is that mesons are able to move in orbits around the atomic nucleus which resemble the orbits of electrons in shape but are in size 200 times smaller. The mesons jump from one of these orbits to another and release energy which should be able to initiate a special type of fission in uranium or heavier nuclei. If they can, the energy release figures out to be about half as much again as the energy given off by uranium that is fissioned by good old reliable neutrons.

A next step in the attempts at practical meson fission will be study of mesons created in new giant "atom-smashers," five of which should be in operation this year.

Top of Cosmic Ray Atmosphere Found

➤ THE TOP of the earth's atmosphere for the cosmic rays that bombard us from outer space has been discovered by scientists who put their instruments into a captured Nazi V-2 rocket that was fired up to 100 miles over the White Sands, N. Mex., Proving Ground last July.

Analyzing the data, they now find that some 34 miles over our heads, the intensity of the cosmic ray bombardment begins to become constant. This is the beginning of what scientists call the "cosmic ray plateau." From this high-altitude region out into space the cosmic radiation is believed to remain virtually constant.

Discovery of the start of the cosmic ray plateau was announced in the Physical Review by Dr. J. A. Van Allen of the Johns Hopkins University Applied Physics Laboratory, Silver Spring, Md., and Dr. H. E. Tatel of the Carnegie Institution of Washington and formerly with the Applied Physics Laboratory.

They put a Geiger counter in the rocket fired at White Sands. As the rocket shot up to an altitude of 100 miles, the scientists received a record of the cosmic ray count by means of a radio telemetering system. The rocket's flight gave them counts of cosmic rays at the highest altitudes at which the mysterious rays have been studied.

Two important discoveries were made from records of the flight:

1. Start of the cosmic ray plateau is at about 34 miles altitude. From this height up to the peak of 100 miles, the cosmic ray count was nearly constant.

2. The intensity of cosmic rays in the space out from the earth is two to three times greater than scientists had calculated on the basis of lower altitude observations.

Below 55 kilometers, or approximately 34 miles, the cosmic rays varied from one or two counts a second at sea level to a peak of 49 counts per second in the neighborhood of 12 miles above the earth. But for the highest 66 miles of the flight, the cosmic ray count was steadily a little more than 22 counts per second.

It is believed that this intensity of cosmic rays extends out into space until the still-unknown source of the radiation is approached.

On the Back Cover

➤ A RACE *toward the center of the atom, to see who can learn the most about the structure of matter, is going forward in all the institutions working in nuclear physics. More powerful cyclotrons embodying new designs are under construction in a number of research centers. In the back cover picture, a technician is installing condensers which will tune the magnet for the new 300 Mev synchrotron being built at Cornell University.*

'Radiation Fighters' Will Be Trained at New Kind of School

Medical Weapons Against Atom

by JANE STAFFORD

➤ AMERICA's major medical offensive against exploding atoms that spread death and destruction will get under way in a few months through the creation in Rochester, N. Y., of a new kind of medical school.

There is urgent need for a new kind of doctor, "radiation fighters," to counter one of the most dangerous aspects of atomic bombs, atomic power plants and other man-made radioactivity.

We need a new first-line of defense against atomic radiation injury in peace or war.

If there ever is an atomic war, our Army and Navy will need medical officers trained to treat atomic casualties.

And peace in the atomic age will bring its new and special toll of accidental atomic casualties unless there are plenty of specialists to plan protection against such accidents.

The first atomic medical school, a part of the University of Rochester and supported by the Atomic Energy Commission, will be a sort of civilian "West Point" for our defenders against the consequences of atomic energy.

Long before the atom bomb, radiation took its toll. A tragic peacetime byproduct of World War I was the poisoning of girls who painted the radium watch dials which became generally popular after discovery of their military usefulness.

The general public at that time knew very little about radium, its power and its danger. Only a handful of people, doctors and other scientists who rarely entered a factory, would have known that it was dangerous to use lips and tongue to point brushes dipped in radium paint.

Today the whole world knows atomic radiation is dangerous. But there are still very few persons who can tell girls in a factory how to handle atomic chemicals safely. Nor would the workers themselves know, any more than the watch dial painters of a generation ago, whether there was danger in a new work method they themselves thought up for greater speed or efficiency.

We need experts to protect us from peacetime developments in atomic energy all along the line, from the miners who dig uranium-bearing ore out of the ground to men and women in factories putting atomic chemicals to new uses and including sick people being treated with them and people living in the neighborhood of our future atomic power plants.

Authorities do not believe that radiation used as a weapon will destroy the fertile greenness of the earth or that the human race will be wiped out in three generations by the effects of atomic radiation on reproductive cells. But they do believe, in fact they know, that much more information is needed on the effects of radiation on all forms of life.

Training scientists who can get this kind of information for us will be one

of the jobs of the new atomic medical school.

To get this new information, they need first to study what is known now of the effects of radiation, how it burns and destroys when it hits the body from outside, and what it does to the blood-forming system, the heredity-carrying genes and other body cells when it gets into the body.

Courses in the new science of health physics will be taught. Knowledge of physics and electronics is needed for making safety measurements that guard against dangerous radiation.

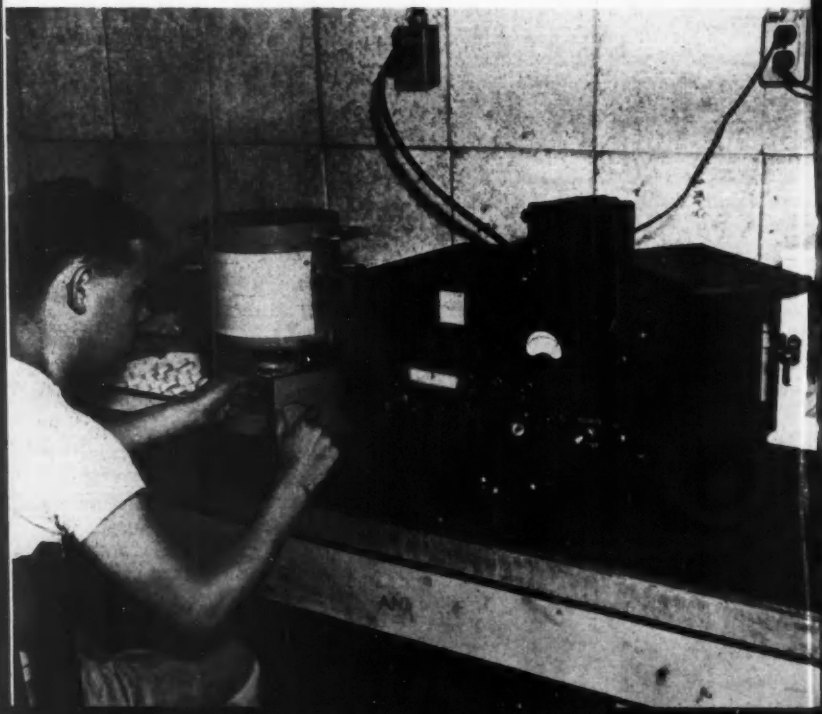
How gases, dusts and aerosols spread must also be studied, since these may carry radioactivity in the air.

Chemistry, toxicology and legal medicine will be other subjects taught in the new atomic medical school.

Medical courses will include both treatment of radiation injury and methods of using the new radioactive chemicals to treat other kinds of diseases, such as cancer.

At Rochester they tell the story of a four-year-old boy brought to the hospital with a cancer of the thyroid gland. Surgeons removed this but the cancer

➤ RADIOACTIVE PHOSPHORUS *isotope is being checked before going from Oak Ridge to a research center where it will be used to study growth. Protecting the health of researchers handling radioactive materials is the goal of the new medical training center at Rochester, N. Y.*



➤ LONG HANDLED *tongs and a careful check-up on radiation at the surface of all shipments are routine precautions being observed here as a consignment of radioactive iodine is sent out for cancer research. Training in such techniques will be available for medical men who wish to become radiation fighters.*

had spread back into his throat and the boy had to have a tube put into an opening cut through his neck from outside so he could breathe. He was given a tracer dose of radioactive iodine and this showed that, fortunately, the cancer was the rare kind that picks up and concentrates iodine. The University of Rochester at that time had only a small cyclotron, so their supply of radioactive iodine was very small indeed. But one of the scientists was just then going to a scientific meeting in St. Louis. He got one of the scientists in that city to run his big cyclotron for the four days of the meeting and brought back with him enough radioactive iodine to save the child. Today, two years later, he is alive and well.

These thyroid gland cancers that can be cured by radioactive iodine are very rare. But scientists hope to find other radioactive chemicals that can

destroy commoner varieties of cancer without damaging the rest of the body. Preparation to search for such chemicals and for the best way of using them will be included in some of the courses at the new atomic medical school.

Public health departments may be sending men and women to this school for training. Suppose a truck or train or plane carrying radioactive material is wrecked and the contents spilled on the roadside, right of way or, in case of a plane accident, into a community water supply. Protecting people from a water supply contaminated with radioactivity is probably just as much a function of health departments as protecting them from water supplies contaminated with typhoid fever germs. But the methods of testing for contamination and protecting against it are entirely different.

The school will take about 100 students at a time. About 30 of them will be taking short courses in health physics and protection technics, including dust counts and other radiation measurements and blood chemistry. Another 30 will be college or university graduates studying for Ph.D. degrees. These will spend at least three years at the school. The remaining 40 will be doctors, either M.D.'s or Ph.D.'s or West Point graduates. Army and Navy doctors in this group will probably take a one-year course, civilian doctors a two-year course.

Taking part in national defense against radiation danger is not an entirely new thing to the University of Rochester. The Manhattan District borrowed its professor of radiology, Dr. Stafford Warren, now at the medical school of the University of California at Los Angeles, to head its health protection and medical activities. And in 1943 the Manhattan District set up a medical research unit across the road from the University of Rochester's School of Medicine and Dentistry. The unit subsequently became the first and, so far, the only project of its kind operated by the Atomic Energy Commission. Its present director is Dr. H. A. Blair.

Discovery of a potential medical weapon against radiation damage, from the atom bomb or from nonmilitary sources, has just been announced by two of this atomic energy project's staff. They are Drs. Paul E. Rekers and John B. Field. Their discovery is that rutin, obtained as a bright yellow powder from the green buckwheat plant among other sources, might save radiation victims by strengthening the walls of their blood vessels. This chemical, they reported, has protected dogs from the uncontrollable and fatal bleeding which is a primary factor in the deaths of humans and other mammals exposed to sublethal and midlethal doses of total body radiation.

But Dr. Rekers and associates are not stopping with this discovery. It came as part of a study of hemorrhage and the effects of radiation on the blood and blood-forming system. That study is continuing and promises further important new knowledge.

The United States has bountiful natural resources of many raw materials needed for modern living but has little or no natural rubber, tin, nickel. manganese, cobalt, industrial diamonds or quartz crystals for electronic equipment.

Radioactive Carbon Collected in Living Things Give Time Scale

C^{14} Can Date Recent Geology

➤ YOU HAVE radioactive carbon in you. You will continue to have it even after you die, and if there is anything left of your remains a few thousand years from now, the radiocarbon in them will still be able to make a Geiger counter tick.

Experiments proving that all living things are collectors of radioactive carbon, C^{14}, were reported to the American Association for the Advancement of Science by Prof. Willard F. Libby of the University of Chicago. The work was done by a group of research workers, under the joint auspices of the Institute for Nuclear Studies at the University and the Houdry Process Corporation.

Theoretical considerations point to the probability that radioactive carbon is produced in the upper atmosphere through cosmic-ray bombardment, and subsequently concentrated in the bodies of living plants and animals. Such carbon has a measured half-life of 5,000 years.

Following a first demonstration of its actual presence in methane produced by bacteria in sewage, Prof. Libby and his associates have now proven its existence in beeswax and wood charcoal. These substances show just about the same radioactivity as is put forth by the sewage methane. As a check, methane from petroleum was tested, and found quite devoid of radioactivity. Although petroleum had an ultimate source in living creatures, they have been dead so long that all their radioactive carbon atoms have "died," too.

One possible application of this new discovery which Prof. Libby pointed out is the more accurate determination of the age of comparatively recent geologic deposits. If they are less than 40,000 years old, the traces of radiocarbon left in them can be measured, and from them a fairly close age in years can be calculated.

Dr. F. R. Eggan of the University of Chicago has told the American Anthropological Association that ashes of a person who died anywhere from 900 to 30,000 years ago may be tested for radioactive carbon to reveal exactly how long ago that person lived. This technique developed in atomic bomb research promises to give an accurate method for dating ancient archaeological sites.

Phosphate Pebbles In Soilless Culture

➤ PEBBLE PHOSPHATE rock from Florida, and crushed phosphate rock with the natural fluorine removed were two of the "gravel" varieties used in experiments on soilless cultivation of hothouse flowers conducted by Dr. Neil W. Stuart of the U. S. Department of Agriculture. This phosphate-rock "gravel" supplied all phosphorus the plants needed for thrifty growth.

For the Home Lab

Electro-Chemistry - I

by Burton L. Hawk

➤ One of the greatest accomplishments of science has been the harnessing of the electron with its resultant benefit to all mankind. In the atom, electrons are constantly spinning about the nucleus held within their orbit by the attractive force of that nucleus. By applying energy to the atom it is possible to increase the speed of these electrons and even to knock them out of their orbits into space. In a copper wire, for instance, the electrons freed from one atom will knock out electrons from the adjoining atom. The process is repeated with amazing rapidity throughout the length of the wire. This constant orderly surge of electrons constitutes a flow of *electricity*.

The simple mechanical energy of rubbing is sometimes sufficient to cause a flow of electrons. To demonstrate, rub a glass rod with a piece of silk, which action forces some of the electrons in the rod to jump to the silk. The rod having lost an electron (negative charge) is now positive. The silk having gained an electron (negative charge) is now negative. If the two objects are brought together, without friction, the opposite charges will attract, the electrons consequently will move back to their original places and an electric current will flow.

Comb your hair vigorously for a few minutes; then hold the comb about ¼ inch away from a small steady stream of running water from the spigot. The stream of water will bend toward the comb, and by moving the comb you can curve the stream of water in any direction you wish.

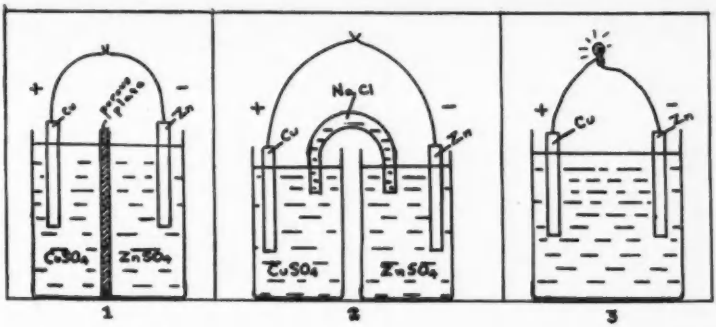
Electro-Chemical Cells

Another method of producing electricity is by chemical reaction; this is the method with which we are primarily concerned.

One type of cell is based on the replacement of copper by zinc: $Zn + Cu^{++} \rightarrow Zn^{++} + Cu$. However, the zinc must not be allowed to be in direct contact with the copper. To accomplish this, a porous plate is inserted in a large container so as to form two separate partitions (Figure 1). A strip of zinc is immersed in a solution of zinc sulfate on one side of the plate and a strip of copper is immersed in a solution of copper sulfate on the other side. The porous plate will prevent mechanical mixing of the solutions, but will not interfere with the passage of ions. Now if a copper wire is connected to the two electrodes, an electric current will flow through it.

If desired, two separate containers can be used for this cell as shown in Figure 2. The inverted U-tube is filled with sodium chloride solution which will permit the passage of ions.

Now just what is happening? When the metals are immersed in the solutions, they tend to form ions and consequently electrons are released: $Zn \rightarrow Zn^{++} + 2$ electrons. However zinc is much more anxious



to make this change than is copper. Result: we have a surplus of electrons around the zinc which constitutes a difference of potential. The electrons then flow along the zinc through the wire to the copper. Here they form copper atoms from the cupric ions: Cu^{++} + 2 electrons → Cu.

Many other chemical reactions can also be used to produce an electric current. For example, sodium chloride solution can be used in both partitions of the cell. One solution is then saturated with chlorine and a stick of carbon is immersed therein. A strip of zinc is immersed in the other solution and the two connected with a wire. Here the energy is produced by an oxidation-reduction reaction. (Zinc is oxidized, chlorine reduced). The electrons released by the zinc, pass through the wire to the carbon pole where chloride ions are formed from the chlorine atoms: Cl_2 + 2 electrons → $2Cl^-$.

(For quick demonstration purposes, it is possible to obtain an electric current by inserting electrodes in the same solution. Simply mix the copper and zinc sulfate solutions in one container and add a little sulfuric acid. Insert the metal strips (zinc and copper) but do not allow them to touch [Figure 3]. We were successful in lighting a flashlight bulb with this set-up.)

Dry Cell

The dry cell utilizes solid materials in its construction instead of liquids. A zinc cup serves as the electrode. This is lined with porous paper to separate it from the solids within. The "solids within" consist of a moist mixture of manganese dioxide, ammonium chloride, some zinc chloride, and a porous inactive filler. A carbon rod is inserted in the center of the mixture which acts as the positive pole. Here the zinc is oxidized (loses electrons) to zinc ions and the ammonium ions are reduced (gain electrons) to ammonia and hydrogen: $2NH_4^+$ + 2 electrons → $2NH_3 + H_2$. The ammonia reacts with the zinc ions to form complex zinc-ammonium ions and the hydrogen reacts with the manganese dioxide as follows: $MnO_2 + H_2 \rightarrow MnO + H_2O$.

Electronics

In addition to passing through solids, electrons may also pass through a vacuum and through rarified gases

with many startling results. The study of the properties of electrons in this capacity is chiefly the interest of the physicist, but we feel a few brief remarks here will be of interest.

When a metal filament inserted in a vacuum tube is electrically heated, electrons are emitted. When another metal strip ("plate") is inserted in the tube and charged positive, it will draw all electrons to it. Sometimes a third metallic element ("grid") is inserted between the filament and plate. A positive charge on the grid will speed up the electrons and a negative charge will slow them down. Here we have the basic essentials of the electron tube and with variations we have the radio tube, amplifier tube, rectifier tube, etc.

Some metals, such as cesium and rubidium, emit electrons when subjected to light, the amount of electrons emitted depending upon the intensity of light. These electrons can be concentrated, amplified and converted into high-frequency oscillations which in turn can be transmitted through space by radio waves. Thus we have one of the basic principles of television.

When certain gases are bombarded with electrons, energy is given off as light—the basis of the familiar "neon" signs.

In addition to mechanical motion, heat and light, electrons can also produce sound. The tone of such an instrument as the Hammond Organ is created by the amplification of electrical impulses into sound waves. This remarkable instrument is capable of producing some 253,000,000 different tones!

But there is not space here to probe deeper into the fascinating realm of the electron. In conclusion, we might say that the scientist has just touched the surface; there is much to be done, new paths to be followed. Who knows what miracles further study of the electron will reveal?

Cutting Oils React With Metals

➤ CUTTING OILS, used to aid the process of cutting metals on lathes and other machines, sometimes react chemically with the metal, the American Society of Mechanical Engineers was told recently by Dr. M. C. Shaw of the Massachusetts Institute of Technology. The fact may become important in the commercial preparation of organic-metallic compounds.

The chemical reaction is due to the fact that a cutting fluid encounters a rather unusual combination of conditions at the point of the cutting tool. The fluid is subjected to high local pressures, high local temperatures, and to highly stressed metal surfaces.

Cutting oils may be animal, vegetable, mineral, or mixed oils. With organic oils, the process could be used in the preparation of the so-called organometallic compounds by a continuous process method. This would replace the present batch process used because of the inflammability and toxicity of the reactants, and the difficulty of starting and controlling the reaction.

New silicone resins promise lifetime finishes for automobiles.

Orb Shattered Into Small Chunks Several Hundred Million Years Ago

Meteorites Come From Ancient Planet

➤ METEORITES, the chunks of iron and stone that occasionally rush flaming down through the atmosphere and make crash landings on the earth, are all shattered fragments of an ancient planet that once revolved around the sun. Dr. Carl August Bauer, of the University of Michigan, told the American Association for the Advancement of Science that this planet was smaller than the earth. It moved in an orbit between those of Mars and Jupiter, where the asteroids or minor planets are to be found today.

Various types of stony and metallic meteorites that have been collected and studied can be fitted into a picture of a planet considerably smaller than the earth but built essentially in the same way. Specifications call for a metallic core of iron and nickel, with the nickel most concentrated towards the center but present in some proportion throughout. Outside of this was a stony shell, again with metal admixtures most abundant in its deeper part, grading down to practically nothing in a thin outer layer corresponding to the stony crust of the earth.

This theory of the ancient planet is made plausible by Dr. Bauer's studies indicating that meteorites may have been "artificially aged" by cosmic-ray bombardment in outer space, very much as whiskey is sometimes hurried through the aging process by ultraviolet irradiation. Thus they are not always as old as they seem.

Heretofore, age of meteorites has been estimated largely on the basis of the small quantities of helium they contain, just as terrestrial rocks are judged. This is because the "orthodox" way for helium to originate is through the slow decay of uranium. This is all very well for earthly rocks, especially for those from well-buried sites; but it has now been shown that helium can also be produced by the impact of cosmic rays on various elements.

This "artificial aging" of meteorites, occurring irregularly, may very well be responsible for the great apparent differences in age among meteorites that have been analyzed, Dr. Bauer suggested. This explanation overcomes the principal objection to the otherwise quite plausible theory that these meteorites are the shattered fragments of an ancient planet.

What tore this ancient planet apart and scattered its pieces throughout a wide zone of planetary space is not even guessed at as yet. But although the fragments of that long-perished planet may not be as old as formerly assumed, they are by no means things of yesterday; for Dr. Bauer assigned to them an antiquity of "several hundred million years."

Meteorite Study Wins Prize

➤ THE thousand-dollar prize of the American Association for the Advancement of Science was awarded to

30-year-old Dr. Harrison S. Brown, of the University of Chicago's Institute for Nuclear Studies, for his paper on elements in meteorites and the earth's origin. Dr. Brown is the youngest scientist ever to receive this prize, which was given for the 21st time at the Chicago meeting.

Further studies may lead to a closer estimate of the age of the earth and of the known universe. Since the age of the cosmos is now variously estimated at from three to ten billion years there is plenty of room for closing the bracket.

One of Dr. Brown's colleagues has isolated a few milligrams of lead from an iron meteorite. Since lead is the final stage in the radioactive decay of uranium, this should materially aid in the determination of the age of meteorites, and hence of other material in the universe, as soon as the uranium content of the original sample has been ascertained.

Dr. Brown was assistant director of the chemistry division at Oak Ridge during the war and the techniques for separation of chemical isotopes developed as part of the work on atom-bomb production are proving useful in his researches.

Pine Trees in Chemical Industry

➤ PINE TREES of the Southern states are destined to play a greater part in chemical industries, it was indicated at an American Chemical Society meeting in Atlanta recently by Dr. Emil Ott, Hercules Powder Company, Wilmington, Del. With recent advances in rosin chemistry, new and better and cheaper chemicals are promised.

Rosin is now converted to chemicals which find wide use in industry, principally in the manufacture of rubber and plastics. Chemical reactions involving rosin are often difficult to control largely because rosin consists mainly of a mixture of several highly reactive resin acids, each having its own chemical properties.

The possibility that easy and commercially feasible methods will be found for the isolation of some of the pure resin acids from rosin is not too remote, Dr. Ott stated. As they become available, use can be made of the special properties possessed by each.

Slash pines and long-leaf pines of the Southeastern states are the source of two-thirds of the 1,250,000,000 pounds of rosin produced each year in the world. Gum rosin is obtained from the sticky liquid exuded by tapped living pines, and wood rosin is extracted from aged pine stumps. Both are about 90 per cent resin acids.

Chemical modifications of resin acids are useful in the fields of adhesives, plastics, paper sizes, soaps, and protective and decorative coatings. One kind of reaction subdues the chemical activity of the acids, producing a salt which is of outstanding importance in the preparation of synthetic rubber. New outlets will follow chemical research.

A waterproof plastic film is being used to eliminate the peeps and squeaks emanating from electric organs.

BAL Eases Recovery From Lead Poisoning: Nitrogen Mustard Tried On Chronic Ill

War Gas Research Brings Cures

➤ LEAD POISONING, once rated a hopeless disease afflicting painters, has been cured by use of a chemical developed during the war to combat war gas.

Complete recovery of a lead-poisoned sailor followed his treatment with BAL, or British Anti-Lewisite, the medical profession was informed by Dr. James G. Telfer, U. S. Public Health Service surgeon.

BAL had proved effective previously in treating poisoning due to mercury, arsenic, and other heavy metals. The BAL chemical literally pulls the lead out of the bones and tissues of the victim's body.

The patient was a boatswain who mixed all the paint used on board his ship, making a special effort to get "good lead paint." He mixed the paints in a small, poorly ventilated space and also stated that he sometimes ate without washing the paint off his hands. He was brought to the U. S. Marine Hospital because of his vomiting, diarrhea and cramps.

Lead poisoning was suspected because of his "pasty" appearance, presence of a "lead line," consisting of a narrow margin of tiny gray or black spots near the edge of the gums, pain in the abdomen and his exposure to lead. It was only after he received injections of BAL that the diagnosis of lead poisoning was confirmed, since the drug increased the discharge of lead from the points of concentration in the body.

This action of BAL is an aid to diagnosis, since the amount of lead excreted can be measured by laboratory methods and thus confirms what is only suspected on the basis of a physical examination.

Two weeks after the first injections of BAL the patient again received the drug. Treatment lasted for five days, after which he was well and was dismissed.

Gas Chemical Promising

➤ ONE OF THE nitrogen mustards, war gas chemical, has brought some improvement to four veterans suffering from an incurable chronic disease known as Boeck's sarcoid, Dr. George E. Snider of the Veterans Administration Hospital at Fort Howard, Md., has reported.

The swelling of the glands went down, the acute inflammation of the iris of the eyes subsided and in some cases vision improved, chest symptoms were arrested, the skin eruption receded, and some patients gained weight. In one patient, treated for almost a year, the disease almost completely disappeared.

The nitrogen mustard which brought this improvement is not yet called a cure for the condition. Patients with Boeck's sarcoid often have periods when they seem to be getting better, so more time must elapse before doctors can be sure the improvement in these four cases was due to the new treatment.

The chemical was given by injecting a dose into the veins every day for four days, allowing a rest period of about a month, and then giving a second series of injections. Nausea and vomiting followed each injection and the number of white blood cells was temporarily reduced.

Boeck's sarcoid, a rather rare condition, is considered an infectious disease, although no germ or virus cause has been found. Cough, shortness of breath and a little fever may occur in some cases and suggest that the patient has tuberculosis. Swollen lymph glands and salivary glands, inflammation of the iris of the eye, and a skin eruption that is painless and does not itch are other symptoms. In the early stages, the patient may not have fever but feels mildly sick with a distaste for food and vague disgestive disturbances.

Almost any part of the body may be affected. Physicians have generally called Boeck's sarcoid a benign, meaning harmless, sickness. More recently they have realized that it may at times involve vital centers and lead to serious damage and even death.

Arsenic, gold, X-rays, radium, ultraviolet light and many other kinds of treatment have been tried without success.

Dr. Snider was led to try nitrogen mustard because this war gas chemical had brought improvement in cases of Hodgkins' disease, which has some similarity to Boeck's sarcoid.

Six Factors Make Teeth Immune

➤ SIX FACTORS that make teeth immune, or resistant, to decay are reported by Dr. L. S. Fosdick of Northwestern University Dental School.

These factors are none of them like the blood substances that give immunity, or resistance, to measles. There are probably no anti-decay substances in the blood. They may exist in the saliva, but so far no one has discovered them. But some people have teeth that are immune to decay and others have periods when their teeth do not decay. Prisoners in German and Japanese concentration camps, for example, had caries, or tooth decay, before but not during the time they were in the camps. Reviewing present knowledge of tooth decay, Dr. Fosdick finds the following six factors in decay immunity:

1. A copious or at least moderate flow of saliva.

2. Ability of the saliva to neutralize acid.

3. The concentration of calcium and phosphorus in the saliva.

4. The anatomy of the mouth and teeth. Perfectly arranged teeth that meet correctly for chewing and biting and that have few pits and cracks or teeth that are widely separated, so that they are relatively self-cleansing, have less tendency to decay.

5. The dental plaque, a tenacious covering on the teeth, and the bacteria in it.

6. The natural resistance of the teeth to acid decalcification.

Petrochemicals for Agriculture

➤ USE IS NOW made in agriculture of chemicals derived from petroleum—"petrochemicals," for convenience.

Oils made from petroleum carry poisonous compounds from the same source in combating insects, fungi and other pests and disease organisms that plague the farmer's crops and orchards, Dr. Gustav Egloff and Mary Alexander of the Universal Oil Products Company stated recently. A hundred-million-dollar-a-year business has been built up largely on this petroleum foundation.

One new product protects plants not by poisoning their enemies but by literally sealing them out. This is polyethylene polysulfide. Sprayed on in the form of a fine mist, it forms a thin, flexible, stretchable film over the vegetables and fruits to be protected. It stretches as they grow, and never gives attacking insects or spores a chance. If its use is discontinued six weeks before harvest, no evidence of the spray can be detected.

Colorless Chemicals Get Color Analysis

➤ COLOR ANALYSIS of colorless chemical compounds is proving useful in unraveling some of the problems encountered in chemistry, nutrition and biology, according to Dr. Laszlo Zechmeister, professor of organic chemistry at the California Institute of Technology.

Chromatography, as this method is called, was applied in the beginning to pigments with color, but several new methods are now available that can be applied to colorless compounds. These include the application of ultraviolet or black light, which causes the compounds colorless by ordinary light to fluoresce with colored light that can be analyzed.

Dr. Zechmeister has been able to probe by means of chromatography into the shape of the molecule and its effect upon the physical properties of a chemical.

He predicts progress in organic chemical research will be speeded by the application of the new methods.

Camphor Grown in U. S.

➤ CAMPHOR can be successfully grown in the United States as far north as Boston, thus rendering America independent of the source of natural camphor on Formosa island off the China coast. Prof. Heber W. Youngken and William E. Hassen, Jr., of the Massachusetts College of Pharmacy have reported to the American Association for the Advancement of Science that the new potential source of home-grown camphor is not the camphor tree of Asia but a shrubby bush from Africa known as the camphor basil. It grew well and healthily as an annual crop when planted in lightly-limed Massachusetts soil. Dried leaves and flowering tops harvested in late October yielded 2.5% of oil and 2.54% of camphor.

Important Patent Issued to Fermi Before Atomic Energy Blackout

Slow Neutron Bombardment

A Classic of Chemistry

Long before nuclear fission was recognized, this prototype of the atomic energy pile was envisioned by a group of physicists in Italy. Among them will be recognized key developers of the atomic bomb in America.

UNITED STATES PATENT OFFICE—2,206,634 (Patented July 2, 1940)—PROCESS FOR THE PRODUCTION OF RADIOACTIVE SUBSTANCES. Enrico Fermi, Edoardo Amaldi, Bruno Pontecorvo, Franco Rasetti, and Emilio Segre, Rome, Italy, assignors to G. M. Giannini & Co., Inc., New York, N.Y., a corporation of New York. Application October 3, 1935, Serial No. 43,462. In Italy October 26, 1934.

THIS INVENTION relates to the production of isotopes of elements from other isotopes of the same or different elements by reaction with neutrons, and especially to the production of artificial radio-activity by formation of unstable isotopes.

It has been known for many years that, although each chemical element has always the same atomic number or charge, it may exist in different forms having different atomic weights. These forms of the elements are referred to as isotopes.

It has also been known that the radio-active elements, by disintegration or break down occurring in their nuclei are spontaneously converted into various isotopes of other elements. Thus, for example, the radio-active element uranium may be converted into lead of atomic weight 206, while the element thorium may be converted into a different isotope of atomic weight 208.

It has long been known that such spantaneous disintegration of radio-active elements is accompanied by emission of alpha, beta, and gamma rays, that is to say, of the helium nucleus, electrons, and electromagnetic radiation of extremely short wave length.

In more recent years it has been demonstrated that isotopes of various elements could be converted into other isotopes of the same or different elements by bombardment with alpha particles, diplons, protons or gamma rays of very high energy, and that the isotopes thus produced may be unstable so as to decompose with features similar to those of the naturally radio-active bodies. That is to say, radio-active isotopes may, in this way, be artificially produced.

Accordingly, it is an object of the present invention to provide a method and apparatus by which nuclear reactions can be carried on with high efficiency and with the heavier as well as with the lighter elements. A more specific object of the invention is to provide a method and apparatus for artificially producing radio-active substances with efficiency such that their

cost may be brought below that of natural radio-active materials.

Our invention is based upon the use of neutrons instead of charged particles for the bombardment and transformation of the isotopes.

All of the prior work on nuclear reactions has been done with high energy particles and every effort has been bent toward increasing the energy of the particles as the means of extending and making more efficient the nuclear reactions. We have now discovered that effort in this direction is sound only when charged particles are used which require tremendous energy to break through the potential barrier surrounding the nucleus; and that if, instead of charged particles, neutrons are used for the nuclear reactions, the greatest efficiencies are in some cases attained with low energy or "slow" neutrons, e. g., of the order of a few hundred electron volts, or even much less down to a small fraction of an electron volt.

Neutrons when produced in any ordinary manner, e. g., by the action of radon on beryllium or of polonium on beryllium or by bombardment of atomic nuclei with artificially accelerated particles, might have a very wide range of energies but high average energy. These energies range up to several million volts. It is necessary, therefore, if the greatest efficiency of reaction is to be attained, to reduce by artificial means the energy of these neutrons. We describe below a method for slowing down fast neutrons.

We have demonstrated that the absorption of slow neutrons is anomalously large as compared with that of the faster or higher energy neutrons. The simplest explanation for most cases is to admit that the neutron is captured by the nucleus with formation of an isotope heavier by one mass unit. If this heavier isotope is unstable a strong induced radio-activity may be expected. This occurs, for example, with silver and iridium which go over into radio-active isotopes. In other cases it is found that no activation, or at least no strong activation, follows an anomalously large absorption. This is the case with many elements, e. g., yttrium and cadmium. In these cases the formation of a stable nucleus upon the capture of the neutrons is to be expected.

In some cases the absorption of the slow neutrons results in the emission of a relatively strong gamma-radiation with energy corresponding to the binding energy of the neutron. This gives a reliable source of very hard gamma rays, even harder than the naturally produced gamma rays, e. g., from radium.

In view of these considerations it is obviously desirable to convert as many as possible of the available neutrons into the slow or low energy condition in which they may be readily captured by the nuclei of the substance being reacted. We have found that it is possible to achieve the desired results by passing the neutron radiation against or through a screen of a suitable material.

The materials which have been found best suited to this purpose are those containing hydrogen (including all its isotopes, but the light isotope which predominates in natural occurrence being most efficient) and especially water and the hydrocarbons, such

as paraffin for example. Other materials, as for example beryllium, carbon, silicon, lead, show this effect to a lesser degree. Other materials, of which iron is an example, do not produce a similar effect to any practical extent, probably because of a relatively large absorption of the neutrons when their energy is reduced.

The increase in activity of the neutrons by such substances is apparently due to two effects both resulting from collisions of the neutrons. In the first place it is readily shown that an impact of a neutron against a proton reduces, on the average, the neutron energy by a factor $1/e$. From this it follows that ten impacts reduce the energy to about 1/20,000 of its original value. Assuming the initial energy to be $4 \cdot 10^6$ electron volts, the energy after ten impacts would be about 200 electron volts and 20 impacts would reduce the energy of the neutron down to a value corresponding to thermal agitation. Thus the first important effect is probably the reduction of the energy of the faster neutrons by impact and the efficiency of hydrogen for this purpose is probably due to the low mass of the hydrogen nucleus. Although we refer to the nucleus, because almost the entire mass is represented by the nucleus, it will be understood that the impact for slowing down may be, and for reasons of economy ordinarily will be, with atoms, i.e., combined nuclei.

The second probable effect is the scattering and reflection of the neutrons.

Hydrogen is so much more effective than any of the other elements for reducing the energy of neutrons that it will ordinarily be used. It must not be overlooked, however, that the elements having a lesser effect offer possibilities for control of the neutron energy. Where neutrons of initially lower energy are used or where their use requires a higher energy than in the reactions with which we are here especially concerned, the less effective elements may be used singly or combined with elements of different energy reducing power.

The density of the energy reducing or scattering substance has also been found to be an important factor. This follows, likewise, from the theoretical explanation given above. If the energy reduction and scattering of the neutrons is due to impact with atomic nuclei, the probable frequency of such impacts will be directly dependent upon the number of atoms in a given space. For this reason such substances ordinarily should be used in liquid or solid (i.e., non-gaseous) form and, so far as is practicable, substances will be chosen having as high as possible a proportion of hydrogen in the molecule. Here again, the gaseous state under various pressures, and substances having less hydrogen offer the possibility for accurate control if less than the maximum slowing of neutrons is desirable.

It will be readily understood from what has been said above that the greatest effect is attained if the source of neutrons and the substance being irradiated are both surrounded by the energy reducing and scattering material. This could easily be accomplished in many cases by immersing the neutron source in a solution or

emulsion of the substance being bombarded. We have illustrated diagrammatically in Figures 1 and 2 arrangements by which this may be accomplished.

In Figure 1 a cylindrical paraffin block 10 is provided with a hole 11 into which is inserted a source of neutrons, e. g., a tube containing radon and beryllium. The material being irradiated is placed above the source on the paraffin block as shown at 12 and is covered by a second paraffin block 13 having a central opening 14 to accommodate the material being irradiated. For the treatment of small amounts of materials the block 10 may be, for example, about 24 centimeters in diameter and about 14 centimeters in height with the neutron source about 2 centimeters under the upper surface. It will be observed that these dimensions give radial thickness of the material surrounding the neutron source approximately equal to the mean free path in the substance of the high energy neutrons.

Where the substances to be irradiated are soluble in or can be suspended in water or a hydro-carbon or other energy reducing or dispersing substance, etc., may be formed and the substances irradiated therein by immersing the neutron source directly into the solution etc. (See Figure 2.)

The hydrogen which serves to reduce the energy of the neutrons may also be in chemical combination with the substance being irradiated.

Figure 2 is a diagrammatic illustration of a neutron irradiating device in which the substance being irradiated is dissolved or dispersed in the energy reducing or dispersing material. A suitable vessel 20 is provided

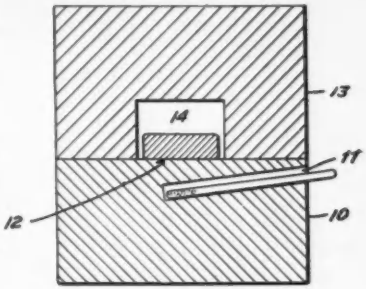


Fig. 1.

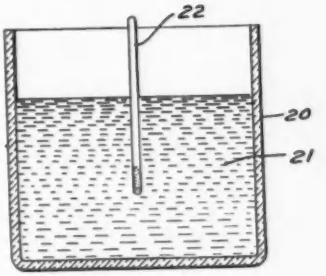


Fig. 2.

for holding the solution or dispersion 21 and into this is immersed the neutron source 22.

Instead of the radon beryllium source, any other source of neutrons may be used, as for example neutron tubes as developed by Oliphant and as more recently developed by laboratories of the General Electric Company and the Westinghouse Electric and Manufacturing Company or cyclotrons as developed by Lawrence. In such tubes deuteron oxide (heavy water), which may be separated by known methods from naturally occurring water, is bombarded with

deuterons accelerated in an electric field produced by a grid tube. The deuteron nucleus is disintegrated with the emission of neutrons.

Obviously the apparatus can be endlessly modified, the essential being the combination of the energy reducing substance near the substance being irradiated, and a suitable source of neutron radiation.

Soilless Radioactive Corn

Getting radioactive phosphorus into chickens, as part of a research project on their feeding, involved going back a whole step and getting it first into the corn that the chickens ate. H. G. M. Jacobson of the Connecticut Agricultural Experiment Station has reported that hybrid field corn was grown by a soilless gardening method in boxes filled with gravel and kept supplied with solutions of a balanced fertilizer-salt mixture. When the corn reached the early milk stage, the ordinary phosphate was discontinued and a radioactive phosphate substituted. The corn plants became radioactive throughout, but the highest activity was concentrated in the grain.

No Resistance Near Absolute Zero

➤ TIN OR TANTALUM electric devices could be operated without loss due to electrical resistance if kept at a temperature within a few degrees of absolute zero, Prof. Mark W. Zemansky, N.Y. City College, declared at the Cooper Union Forum. Cheap helium is a present essential to maintain the low temperature.

These metals, as well as lead, mercury, indium and probably others, offer no electrical resistance to an electric current at near absolute zero temperature because of peculiar physical properties possessed by them in this extreme cold. They become what scientists call superconductive.

An electric current once started in a ring of superconducting metal continues undiminished for as long a time as the metal is maintained cold enough to be superconducting, Prof. Zemansky stated.

Absolute zero is approximately minus 459 degrees Fahrenheit. It is the temperature at which, in theory, any substance would have no molecular motion and therefore no heat. It is a temperature that has never been reached, but temperatures within some few degrees of it have been reached with the aid of liquid helium.

Temperatures lower than one degree absolute are produced magnetically, the professor explained. Certain complicated salts, such as alums and rare-earth sulfates, cool off when they are demagnetized. If such a salt is magnetized strongly while it is at a temperature of one degree absolute, then surrounded by an evacuated space, and then demagnetized by switching off the magnet, the temperature will drop to extremely close to absolute zero.

On the basis of experiments on magnetic cooling, it seems certain that absolute zero can not be reached in this way, he declared. It is generally agreed among physicists that absolute zero can never be reached by a finite number of finite processes of any sort.

➤ WHICH CRYSTAL *face is which? Dr. Allen T. Gwathmey, left, research associate in chemistry at the University of Virginia, shows two students how the single crystals they helped him form and then machine into the shapes of a cylinder and a sphere can be used to measure reaction rates. Their results in determining differences in reaction of individual crystal faces are displayed on the charts in the background.*

"Super Crystals" For Study

➤ "SUPER CRYSTALS" of metal created by University of Virginia chemists are aiding research on surface chemistry which may help industry speed production or slow down corrosion.

Measuring up to one inch in diameter, the crystals are huge compared with millions of tiny crystals on the surface of ordinary metal. Because the sides of any crystal react differently to the same chemical process, the new, giant crystals are opening up a new field of research on metals.

From this study may come crystal faces on metals which are suited to special uses in industry. Thus, crystal faces with low reactivity might be used to reduce corrosion. Highly reactive surfaces might be developed to speed up reactions in the production of many products.

Dr. Allen T. Gwathmey, research associate in chemistry at the University, developed the "super-crystals" with the assistance of advanced students.

From Oil Shale
To Invisible Ink

The Month's Patent Scene

If you would like a copy of the complete specification of any patent, order by number, enclosing 25 cents (not in stamps) for each one ordered, from the Commissioner of Patents, Washington 25, D. C.

Steam For Oil Extraction

➤ AFTER RECENTLY EXPERIENCING the first real pinch of an oil shortage, efforts are being redoubled to find a high-efficiency, low-cost method for getting oil out of the billions of tons of our still-unused oil shales. A different approach is embodied in U. S. patent 2,434,815, granted to Richard J. Shaw of Redondo Beach, Calif.

Instead of trying to extract the oil by roasting or other external heating process, Mr. Shaw treats the crushed shale with low-pressure superheated steam as it slowly slides over a perforated plate underlain with crushed rock. The rock traps powdered shale particles in the oil that flows out, leaving the filtered oil to flow on downward into a collector. Volatile hydrocarbons mixed with the steam are condensed out and added to the oil stock, while the water from the condensation is led off for the extraction of ammonia and other valuable byproducts.

The residue of the shale, still containing unextractable but combustible solids, is discharged into a firebox, where an air blast forces it to yield the last of its fuel value for the production of more superheated steam. The inventor has assigned his patent rights to the Union Oil Company of California.

Tin From Low-grade Ores

➤ TIN, which was perhaps this nation's greatest metallic lack during the war, can be extracted from low-grade ores and other unpromising sources by a new process on which Irving E. Muskat of Glenside, Pa., has taken out patent 2,434,284. The ore is mixed with coal and roasted for about an hour, then treated with a solution of caustic soda. The tin enters into combination as sodium stannate hydrate, which is subsequently electrolyzed to extract the pure metal.

Viscosity Measure

➤ TO MEASURE how viscous, or "thick," oil or any other liquid is, Theodore A. Cohen of Chicago has invented a new device. A spherical weight is allowed to sink through a column of the liquid. At two points it passes between two electrically charged plates. The disturbance it thus causes times its rate of sinking through the measured distance, which is an expression of the liquid's viscosity. The patent number is 2,434,349.

Easing the Censor's Life

➤ THE CENSOR'S LIFE is not an easy one, but an F.B.I. chemist, Dr. Joseph W. Magee of Arlington, Va., comes forward with a device to facilitate his work at least a little. It mechanizes the detection of invisible inks by automatically swabbing on all the known chemicals for showing them up, while

the suspected sheet is slowly moved along on a platen. This replaces the messy and laborious hand application of the reagents, long in use. Rights in the patent, No. 2,434,942, are assigned royalty-free to the government.

For Seasickness

➤ A SEASICKNESS preventive and remedy used by the Army during the war has at last been awarded its patent: No. 2,434,635. Essential ingredients are sodium iso-amyl ethyl barbiturate, atropine sulfate and a scopolamine compound. The patentee, Dr. Llewellyn L. Barrow, now with G. D. Searle and Company, Chicago, has assigned rights to manufacture and use royalty-free to the government.

All-Tobacco Paper

➤ ESPECIALLY-GROWN leaf tobacco for cigar wrappers may soon be replaced with paper-thin, all-tobacco sheets manufactured by a process for which the government awarded patent 2,433,877 to Franklin H. Wells, Ridgewood, and Frank J. Sowa, Cranford, N.J. The tobacco paper retains all the aroma, taste and color of the smokers' weed, and can be handled as if it were natural tobacco leaf. The patent has been assigned to International Cigar Machinery Co., Flemington, N.J.

The same tobacco film can be used for cigarette making as well. The process under which it is prepared consists in reducing the tobacco to a fine powder, adding water which contains a peptizing agent, regrinding wet, and then spreading in a very thin sheet and drying.

Diastase From Grain

➤ Two U. S. Department of Agriculture chemists, Irwin W. Tucker and Dr. Arnold K. Balls, assign royalty-free to the government rights in their patent 2,434,874, on a method for obtaining starch-digesting diastase from finely ground grain instead of from malt, as in the traditional method. They add to a watery mixture of the ground grain a sulfite salt to digest the protein and release the enmeshed starch grains, at the same time freeing the diastase in water-soluble form.

Electron Camera

➤ A NOVEL-TYPE electron camera, useful in metallurgy and other industrial applications of physics and chemistry as well as in straight research, has been patented by Norman R. Davidson, of the RCA laboratories at Princeton, N. J. It is of the type that does not make photographs of the object, but instead bounces an electron beam against a small spot on its surface, to have its course changed and thus produce a series of concentric curves, as meaningful to the technically trained eye as the lines in a light spectrum. These are known as diffraction patterns.

The new feature in Mr. Davidson's camera is the bending of the electron beam into a semicircular arc by means of a magnetic field introduced into the diffraction chamber. The specimen to be examined is so positioned that its surface is just tangent to the curved beam at the top of its arc. Where the disturbed beam falls, at the end of its path, are devices for introducing either a fluorescent screen for visual examination of the diffraction pattern, or a photographic plate for making a permanent record. Rights in the patent, No. 2,435,386, have been assigned to the Radio Corporation of America.

Drier for Frozen Serum

➤ A MACHINE for drying such heat-sensitive materials as blood serum, hormones, egg albumen and certain other foods and drugs is offered by S. O. Levinson and Franz Oppenheimer of Chicago for patent 2,435,503. It keeps the material frozen, but at the same time encourages it to give up its water by exposing it to a source of infra-red radiation. The water vapor is carried off by a stream of an inert gas such as hydrogen or helium when there is danger of oxidation through exposure to air. Patent rights are assigned to the Michael Reese Research Foundation.

Metal Surfacing

➤ SURFACING metal objects with the extremely hard compound, tungsten carbide, is accomplished in the invention of H. S. Hatfield of Hildersham, England, by first coating the object with the carbide in powdered form, then subjecting it to an intense cathode-ray bombardment. This invention is protected by patent 2,435,273.

Non-Spoiling Whipped Cream

➤ WHIPPED CREAM without whipping, and non-spoiling at that, is the promise of patent 2,435,682, granted to Charles A. Getz of Glen Ellyn, Ill., assignor to Aeration Processes, Inc., of Columbus, Ohio. Instead of beating air into the cream, to be imprisoned as bubbles, he forces in nitrous oxide under pressure. Nitrous oxide is soluble in the cream. When the latter is released through a valve, the removal of pressure causes the nitrous oxide to come out as gas, forming a frothy mass recognizable as whipped cream. One desirable by-effect of the gas, the inventor claims, is the inhibition of spoilage bacteria.

Fluorescent Test for Oil

➤ SAMPLES of stone and earth brought up by prospecting drills can be examined for oil by a new fluorescence test on which patent 2,435,843 has been issued to W. P. Rand of Pittsburgh. He immerses them in a non-fluorescing solvent such as chloroform, ether or alcohol, turns on an ultra-violet lamp, and watches the "plumes" of shining color that rise from hidden bits of oily material and fan out into the liquid. Rights in the patent are assigned to the Gulf Research and Development Company.

Film Developing Camera

➤ FOUR PATENTS, 2,435,717 through 2,435,720, have been granted to Edwin H. Land of Cambridge, Mass., on his camera that develops pictures as fast as they are taken, by means of fluid from a reservoir in the camera, spread with a second, transparent film. The method is applicable to cut film in magazines as well as to roll film.

Sulfite Liquor for Cement

➤ SULFITE WASTE liquor from papermills, one of the most troublesome of industrial wastes, is at last beginning to find a useful place in the world. First, it is subjected to a fermenting process, to convert remaining soluble carbohydrates into alcohol; then the remainder, either in liquid form or evaporated down to its solids, is added to cement to speed the setting and curing processes in making concrete. This process is covered by patent 2,435,594, assigned by its inventor, Donald R. MacPherson of University Heights, Ohio, to The Master Builders Company of Cleveland.

New Anti-Fouling Method

➤ BARNACLES, algae and other bottom-fouling growths on ships, that now

necessitate frequent time-consuming, costly dry-dockings and scrapings, can be kept from getting a good start on their nefarious careers by a new electrochemical method that applies killing agents while the vessels are lying at the wharves, discharging or taking on cargo, being fueled, etc. U. S. patent 2,435,986 has been issued to the executor of the inventor, I. M. Taylor of Boston.

The device consists essentially of a large net of heavy wire, behind which is stretched a sheet or pad of canvas. This lies on the bottom as the ship is brought up against the wharf, with the inner edge pulled up to the surface and the outer edge held in place by ground-anchors on the bottom. When the ship has been made fast, the apparatus is hauled snug with suitable tackle, confining a layer of water between canvas and hull.

Then a chemical mixture capable of releasing chlorine or other poisonous chemical is poured into this layer of water. An electric current discharged through the wire net decomposes the chemicals, and the chlorine proceeds to act on the fouling organisms while they are still young and vulnerable.

Three-Metal Plating

➤ A BRIGHT SILVERY alloy plating is provided by the three-metal bath on which patent 2,435,967 was granted to G. W. Jernstedt of Belleville, N. J., assignor to the Westinghouse Electric Corporation. The metals used are copper, tin and zinc, with an alkali carbonate as an essential ingredient of the solution.

Protection for Pipelines

➤ WEAK ELECTRIC currents protect pipelines from the corroding effects of electrolytic action between their metal and the surrounding soil, Joseph H. Wood, Jr., of Dallas points out in the preamble to patent 2,436,683. Gasoline- and windmill-driven generators have been costly and not too effective. He therefore proposes to use the flow of oil, water or other liquid through the pipe as the source of power. At intervals, small, very simply built generators are installed in by-passes through which part of the liquid flows. The current production is constant and the generators are well protected. Rights in the patent are assigned to the Atlantic Pipe Line Company.

For Cold Polymerization

➤ SOME OF THE weldings of little molecules into big ones, in the process known as polymerization, have to be conducted at low temperatures—from freezing point to a hundred or more degrees Centigrade below it. R. A. Gerlicher of Cranford, N. J., has built a huge mixing bowl for this type of industrial operation; it is nested in an outer casing containing a refrigerant, like a grapefruit half in a dish of ice. Patent 2,436,767, issued on this invention, has been assigned to Jasco, Inc., of Louisiana.

Mineral Sediment Trap

➤ A SEDIMENT TRAP for streams is the subject of patent 2,436,630, granted to Andrew J. Clegg of Santa Rosa, Calif. It consists of a horizontal concrete chamber with a top opening into which a slotted grill is fitted. The sediment drops through that, as your dime drops through a sidewalk grating at the bus stop. A well with a manhole at the end permits removal of the trapped material, which sometimes is valuable, as when the stream drains a mineral-rich region.

Radioactive Isotopes And Enzyme Inhibitors

Chemical Treatments For Leukemia

➤ TREATMENT with radioactive phosphorus alone or with X-rays has given extra years of useful, comfortable life to patients with chronic leukemia, Drs. John H. Lawrence, R. Lowry Dobson, B.V.A. Los-Beer and Bruce R. Brown of the University of California report in the *Journal of the American Medical Association*.

The average length of life in their patients is now 3.7 years, during most of which normal activities can be carried on. Hope of extending life still further for these chronic leukemia patients is held by the scientists. For the past six years they have been testing other radioactive chemicals in the search for better weapons against leukemia.

Since 1936, when radioactive phosphorus from the university's cyclotron was first used to treat leukemia, 129 patients with the chronic myelogenous form of the disease have been treated. All but 21 of these 129 are now dead, showing as has been stressed many times, that the treatment is not a cure.

But 21 are alive and of these, 17 are alive four or more years after the start of the disease, and two are alive nine or more years after the start. Among the entire 129, there were 33 patients who have lived or are now living five or more years after the start of their treatment.

The experience with these 33, the doctors point out, "is a reminder that many patients with chronic leukemia have many years of relatively comfortable life and it is not possible to predict which these will be when they are first seen."

X-rays have long been the accepted medical weapon against chronic leukemia. Use of radioactive phosphorus was begun when studies with the first amounts of it made in the cyclotron showed that after injection into mice the bone marrow, lymph nodes, liver and spleen picked it up in greater amounts than other tissues of the body. Lymph nodes, bone marrow, liver and spleen, which are the organs involved in blood-making, are the ones affected by leukemia.

Radioactive phosphorus has the advantage over X-rays of being easier to give (patients can take it by mouth or have it injected) and of not causing radiation sickness. Unfortunately, like X-rays, radioactive phosphorus in large doses can harm normal as well as cancerous tissues. The differential is 10 to one, which does not allow doctors to give a big enough dose to cure the disease.

The radioactive phosphorus now being used comes from neutron bombardment of sulfur in the atomic pile, but it is identical with that made in the cyclotron.

Radioactive Arsenic

➤ ARSENIC made radioactive in the atomic pile is now being tried in the treatment of leukemia and Hodgkin's

disease, a group of University of Chicago and Argonne National Laboratory scientists reported at the recent meeting of the American Association for Cancer Research.

The scientists are Drs. William Neal, Leon O. Jacobson, Austin M. Brues, Howard Ducoff, Robert Straube and Thomas Kelly.

"Very nice responses" have been obtained in some of the 12 patients treated so far. But, Dr. Jacobson cautioned, he does not know how long the improvement will last or even whether the present improvement is any better than the temporary responses obtained with other kinds of radiation treatment.

Use of the radioactive arsenic was started about nine months ago. It is being tried in the hope of obtaining both the chemical effect of ordinary, stable arsenic and the radiation effect of the radioactive chemical. Arsenic, as physicians know, has been used for treatment of leukemia and allied conditions since 1878.

The radioactive arsenic was first used in tracer studies on both laboratory animals and humans. These studies showed that the chemical was quickly and widely distributed throughout the body, which meant that its penetrating rays would get to the parts of the body where they were needed. The tracer studies also showed that the chemical is rapidly excreted, so there would be no danger from over-long irradiation.

Additional safeguard in the use of radioactive arsenic is the existence of BAL, or British Anti-Lewisite. This chemical can remove radioactive arsenic from the body as quickly as it removes the stable form of arsenic.

The radioactive arsenic used is arsenic[76]. It has a short half-life, 25 hours, and must be used pretty rapidly after it comes from the atomic pile. It is made by pile irradiation of cacodylic acid, dimethylarsinic acid, As $(CH_3)_2$ O·OH.

Chemical Adaptation

➤ A CHEMICAL adaptation treatment that has been helping patients with leukemia, Hodgkin's disease and cancer was reported by Drs. Herman Bolker, Maurice M. Black and Israel S. Kleiner of Brooklyn Cancer Institute and New York Medical College to the American Association for Cancer Research.

The chief importance of the treatment method, the doctors believe, lies in the clues it gives to possible chemical solution of the cancer problem. They do not consider the method itself a cure for cancer or any malignant disease. But they believe it should be included with other methods of treatment.

The chemicals used are enzyme inhibitors. They interfere with or block enzyme chemicals needed by the cancer cells. But the cancer cells soon adapt themselves to life without one of these enzymes. At this point, the doctors do some adapting. They adapt the treatment by giving different chemicals, which stop a different set of enzymes needed by the cancer cells. When the cancer cells, in turn, adapt to this situation, the doctors switch chemicals again.

Nitrogen mustards and X-rays are also used by the doctors as they adapt their treatment to hit the cancer cells in every vulnerable part of their living processes.

A typical course of adaptation treatment was that given to J. F., a 32-year-old woman who had had Hodgkin's disease for two years when she came to the Brooklyn Cancer Institute. After various diagnostic tests, she was given fluorides and iodoacetic acid. Within three weeks her condition improved. When the improvement seemed to be slowed, malonic acid was given. This was followed by rapid improvement for several weeks. When that improvement waned, all the previous medicines were stopped and she got sodium azide. This interferes with a different enzyme system. These two were alternated for a time, and then she was given nitrogen mustard which again brought improvement for a short time. After she relapsed, the first set of medicines were given, to be followed by the second set with X-ray treatments.

After each type of treatment she improved, and as soon as the gain slowed, the treatment was varied. At present, a year after the treatment was started, she is active and well. At no time during the treatment was her condition as bad as before the adaptation treatment was started.

Other patients have shown equally good responses, though some have died after being helped temporarily. Most of the 100 patients treated so far have been in advanced stages of the disease, when no other treatment helped. The doctors suggest that the adaptation treatment should be used for patients who have become resistant to X-ray treatment, since the adaptation treatment seems to make the cancers radiosensitive again.

Until a definite cure for cancer is available, they point out, all available methods of treatment should be used. The striking beneficial effects of X-rays, hormones and chemical agents in treating various malignant diseases have all been limited by the occurrence of adaptation and loss of therapeutic efficacy. It is important to realize, they concluded, that benefit may occur by the use of appropriate agents which may either reverse the insensitivity or provide a therapeutic response of their own.

Chemical Smell Too Much for Ticks

➤ A "SOCIALLY IMPOSSIBLE" insecticide that is used less than it might be because of its disagreeable musty odor has had its handicap turned into an advantage in at least one case, U. S. Department of Agriculture scientists report.

Benzene hexachloride, which cannot be used for food-plant protection because nobody would want to eat the food afterwards, has been used effectively against a highly specialized cattle parasite in the Southwest, a tick that attacks only the insides of the animals' ears.

Pine oil containing from three to five per cent of benzene hexachloride, when squirted into cows' ears, not only kills the ticks already present but serves as a repellent to hold new attackers at bay for at least 17 days. Counting both killing and repellent action, one dose "de-ticks" a cow for about a month, at the cost of one cent per ear.

Ergosterol for Tuberculosis:
Vitamin K for Chilblains

Vitamin Chemicals In Medicine

➤ GOOD RESULTS in treating tuberculosis with the parent chemical of vitamin D are reported by Dr. Walter Raab of Glenn Dale Sanitorium near Washington, D.C.

Four patients given this chemical for six months showed more improvement than could be expected by bed rest alone. TB germs disappeared from the sputum in three of the four cases. The fourth was a patient with a large cavity in the lung.

The chemical used is ergosterol. This chemical turns into vitamin D, the anti-rickets vitamin, under the action of sunshine or artificial ultraviolet light. Both the vitamin and its parent chemical have an anti-TB germ action, but the vitamin proved toxic when tested in guinea pigs with tuberculosis. It made the animals shiver, their hair stood on end and they lost their appetites. Ergosterol, the parent of the vitamin, did not have this effect and did suppress the tuberculosis in the guinea pigs. So Dr. Raab decided it would be safe to give it to human TB patients.

The ergosterol treatment is not the kind of chemical treatment that sulfa drugs are for other germ-caused diseases. Nor does Dr. Raab consider it vitamin treatment. The effects may be due to a building up of body resistance to the germs. TB patients will still have to go to a hospital and rest in bed if given this treatment.

New Treatment for Chilblains

➤ A NEW TREATMENT for chilblains consists in doses of vitamin K, the anti-bleeding vitamin. Favorable results with a trial of this treatment during the prolonged spell of severe weather in England last winter are reported by a British physician, Dr. D. P. Wheatley.

Factors predisposing to chilblains are believed to be defective circulation in the extremities, increasing permeability of the walls of the blood vessels and lessened clotting ability of the blood. Since these same abnormalities are present in persons deficient in vitamin K and are corrected by giving the vitamin, he tried the vitamin as a remedy for chilblains.

One of his patients was a 37-year-old man who had suffered from chilblains "ever since he could remember." No other remedy had helped and when Dr. Wheatley saw him all his fingers and toes were dusky red and swollen, with signs of ulcers on several of the toes. He was given one injection into his muscles of a synthetic vitamin K. A week later he reported in delight that for the first time he had obtained relief from the chilblains. His fingers were normal and the toes had only a slight swelling left.

Complete relief of signs and symptoms was obtained in another three patients and improvement in four more. Although giving the vitamin

by injection was considered better than giving it by mouth, the injections caused considerable pain and had to be abandoned.

Vitamin C in Whale Milk

➤ YOUNG WHALES get concentrated vitamin in their mothers' milk, it appears from analyses. Prof. Michael Begg of Marischal College, Aberdeen, reports that in a small quantity of milk from the main duct of the mammary gland of a captured Antarctic fin whale the rickets-preventing ascorbic acid (vitamin C) had nearly double the concentration of the same vitamin in cow's milk at its best. It was close to the best assay for vitamin C in human milk.

Gases as Industrial Aids

➤ THE IMPORTANT part played by gases and gas mixtures as aids in manufacturing processes was emphasized recently at a meeting of the American Society of Mechanical Engineers. At least 75 specific gases or mixtures have been reported by industries as used, about one-half of them being considered of major importance.

More knowledge of the properties of gases than now exists is an essential in making the best uses of them. A special committee of engineers reported on a survey of many industries to determine their uses and the existing need for further information about their properties.

The physical and thermodynamic properties of gases are among the tools used by engineers in many calculations, Dr. Newman A. Hall of the University of Minnesota told the society. While standard tables of gas properties are now in use, basic data are often inadequate as new design problems are faced in many industries.

Petroleum refining has an extensive need for gas properties data. In the chemical industry, adequate information on mixtures of even some of the more common gases, such as oxygen and nitrogen, is needed. Although the refrigeration and air-conditioning industry has been established for many years, current developments are characterized by an increasing amount of engineering refinements. Twenty-five or more gases are used as refrigerants, of which at least half have their major application in this industry.

The survey shows that priority of interest is in the following groups of gases in the order named: basic gases, hydrocarbons, gas mixtures, refrigerants, inert gases, disassociated gases, minor atmospheric gases, and propulsion gases.

The basic gases include oxygen, nitrogen, water vapor, carbon dioxide, hydrogen and carbon monoxide. The hydrocarbons are of particular importance in the petroleum field. The gas mixtures include oxygen-nitrogen, nitrogen-methane, carbon monoxide-water vapor, and others. The inert gases include helium, argon, neon, krypton, xenon and radon. The minor atmospheric gases are ozone, oxides of nitrogen and others. The propulsion gases are those used in aircraft.

Bacitracin Being Tested In Nine U.S.A. Cities

Anti-germ Chemical on Trial

➤ BACITRACIN, one of the new anti-germ chemicals of the penicillin class, is now becoming available in sufficient quantities to get special trials in nine different cities. Its discoverers, Dr. Frank L. Meleney and Miss Balbina A. Johnson of Columbia University College of Physicians and Surgeons, explain that the trials are carefully planned to show the possibilities and best ways of using the new remedy before it goes on sale generally. The U. S. Food and Drug Administration is setting up tentative standards and specifications for potency and safety.

The nine cities selected for the clinical trials of the new drug are: New Orleans, San Antonio, Rochester, Minn., Madison, Wis., Cincinnati, New York, Philadelphia, Baltimore and Charlottesville, Va. They were chosen in order to get a wide variation in climate, temperature, general physical condition of patients and differences in economic level. All these factors can affect the results of treatment with a drug.

Favorable results have been obtained in 86% of the 186 cases of surgical infections already treated by local application of bacitracin. These cases ranged from boils and styes to such serious conditions as cellulitis and chronic osteomyelitis.

Bacitracin is an antibiotic, or anti-germ chemical from a germ, obtained from a strain of Bacillus subtilis found in the tissue removed in cleaning up the wound in a compound fracture case. Because the patient's name was Tracey, Dr. Meleney and Miss Johnson named the strain of bacillus the Tracey strain and the antibiotic it produced bacitracin.

It was used at first to treat surface infections by local application. It has now been purified so that it can be safely given by injection in cases in which the infection has spread beyond the local area and is involving the body generally.

New Antibiotic Types Needed

➤ ANTIBIOTICS, or drugs like penicillin and streptomycin, are being developed at a bewildering rate; yet the future holds challenges that scientists have not yet begun to meet, Prof. Selman A. Waksman of Rutgers University, pioneer in this field, declared. Molds and bacteria that produce only one antibiotic apiece are outdistanced now by species that produce as many as half-a-dozen.

Among the needs that must be met, Prof. Waksman listed antibiotics that will attack filterable viruses, and others that will act against abnormal tissue growths like tumors. It is also desirable to overcome the development of resistance in certain bacteria to the action of antibiotics. Finally, we still need to find out how antibiotics work.

NH_3 Injected Into Soil or Dissolved in Irrigation Water

Gaseous Fertilizer

Reprinted from the Industrial Bulletin of Arthur D. Little, Inc.

▶ A NEW wrinkle is being added to the age-old nitrogen cycle, whereby nitrogen from the air enters the soil to feed growing plants. For many years, ammonia gas has been made from nitrogen in the air and converted into solids, such as ammonium nitrate or sodium nitrate, for use as fertilizers. Now it is found that the ammonia itself can be used as fertilizer at low cost. In 1947 over 200,000 acres in the Mississippi Delta were fertilized with ammonia. Those familiar with the development expect that more than a million acres will be so treated in 1948.

Ammonia is transported as a liquid, under a pressure which varies with temperature and is 197 pounds per square inch at 100°F. For farm application, it is fed from a pressure tank on a tractor out through hollow applicators which cut the soil from four to six inches below the surface. Usually a disc hiller or plow folds the earth over and a wheel compacts the surface to prevent losses of ammonia to the atmosphere. Fifty pounds of ammonia to an acre is a representative rate of application. Addition of ammonia directly to irrigation water is common practice in sections of California and Arizona; direct application to the soil is also practiced in these areas. In Louisiana, water solutions of ammonia are being used as fertilizer.

Ammonia itself may be utilized as fertilizer by some plants in some stages of growth, and it is readily converted to nitrate in the soil. Depending on soil conditions, this conversion may take from a few hours to several months. The time of conversion is favorable, because many young plants thrive better on ammonia than on nitrate, but as plants mature, the nitrate is preferable. Ammonia is used both before planting and during the growing season, when it competes with nitrogen-containing materials such as sodium nitrate, ammonium nitrate, and urea.

Ammonia has been used largely for corn and cotton, but intensive development work is now being conducted on small grains and sugar cane. Storage capacity in the Mississippi Delta area for the ammonia fertilizer is well over four million gallons today, and is rapidly increasing. Probably more than two thousand machines to apply the fertilizer have been constructed, and other units are now in progress.

Nitrogen in ammonia is reported by many users to be less expensive than other forms of nitrogen, and the equipment to apply it is not unduly expensive. Since nitrogen in ammonia appears to have a plant nutrient value at least equivalent to that in ammonium nitrate, manufacturers of solid nitrogen compounds and exporters of Chilean nitrate may face important competition.

Draft Law Like Last War's Courts U.S. Scientific Suicide

Too Few Young Scientists

➤ PROPER UTILIZATION of scientists and engineers in the fields in which they are trained in the event of a new selective service act was urged upon the Senate Armed Services Committee by Dr. Charles Allen Thomas of St. Louis, president of the American Chemical Society and executive vice-president of the Monsanto Chemical Company.

Highlights of his statement are:

The nation already has too few scientists, due in part to the selective service law of World War II. Modern war depends more and more upon the technological strength of a nation. Although the fruits of technology are material, the strength of science and technology is no greater than the caliber and number of the men.

A study conducted by the General Staff of the United States Army which showed that only 30 per cent of the scientists and technologists in the armed forces were completely utilized in the last war.

The induction and assignment of promising scientific students to non-scientific jobs in effect created a lost generation of scientists, so that, at the present time, we find our supply totally inadequate.

A draft law which repeated the errors made in the last war would be courting scientific suicide in the United States.

The selective service law itself and the regulations under which that system worked, failed to recognize the essential contributions that the scientists could make in the over-all war effort if kept employed in their professions on war work.

Neither our allies nor our enemies in the last war made the same mistake. They not only husbanded their scientific talent, but, in many cases, attempted to stimulate the study of science among their youth, even in the darkest days of the last struggle.

The weapons of the next war are still in the various stages of research and experimentation, and weapons to come will possibly come from the basic research and technological applications springing from the brains of our future scientists.

The technological success of the nation's weapons in future years will rest largely in the hands of the youngsters of today who are now studying in preparatory and high schools or just entering college. If the nation is to be strong technologically, we need this coming generation of scientists.

A positive approach and a long-range viewpoint should be taken in making certain that the scientific and engineering talent be allowed to stay at production work where training is most valuable. The future supply of most promising students of science must be protected.

Scientists and technologists who are engaged in their profession should be fully trained in industry, in government laboratories or in universities, and those going into the armed serv-

ices should be utilized within their professional training.

Outstanding science students should be deferred under a quota system so that they can complete their scientific training. This need not be an over-all blanket deferment of science students, but rather the more promising could be deferred.

This could be done in a number of ways, either by relying upon the teachers themselves or by giving some over-all agency, such as the National Security Resources Board, working with the National Research Council, the power to decide on the quota needed and to make arbitrations in case of disputes and misunderstandings. There should be some mechanism for the protection of scientists in universities who are engaged in teaching or research.

Plastic Coats for Eggs

➤ PLASTIC coats for eggs that will keep them fresh outside a refrigerator for a year.

A new sulfa drug for animals that ought to save a couple of hundred millions of dollars annually down on the farm.

Flame-resistant paints for inside walls that don't need inflammable solvents to carry the new mode synthetic protecting film.

Fortified margarine with a longer-lasting vitamin A content.

A better phosphorus-containing substitute for nicotine (for killing insects, not smoking) that slays bugs that defy DDT.

A new complex liquid, christened DABP, that among other things can bind cloth of glass into a strong, semi-transparent "sandwich."

And a way of using the "drip" from frozen foods, the gooey stuff that comes out of the frozen edibles, to tell just how it is getting along in storage—"almost as important as the information obtained from an examination of human blood," says the scientist.

These new chemical developments were announced to the joint meeting of the American Association for the Advancement of Science and the American Chemical Society in Chicago.

Dr. Gustav Egloff of the Universal Oil Products Co. told of the plastic film for eggs and the sulfamethazine that promises to control mastitis in cows, shipping fever in horses and some chicken diseases.

L. E. Ludwig of Montgomery Ward Paint Works told of the new paint made of vinyl polymers in water dispersions. A. I. Coombes of Wilson & Co., Chicago, told of the cheaper and long-lasting method of enriching margarine. Prof. L. F. Audrieth and Dr. O. F. Hill of the University of Illinois made atomic geometry studies to pep up the German-born insecticide, HEPT, or hexaethyl tetraphosphate to chemists.

Arthur D. F. Toy, Lee V. Brown of Victor Chemical Works, Chicago, discovered the plastic, diallyl benzenephosphonate. Prof. Socrates Kaloyereas of Louisiana State University studied the drip.

Fundamental Definitions Restated In Light of New Discoveries

Laws of Matter Up-to-Date

Compiled by HELEN M. DAVIS

1. A single ATOM is the tiniest particle of any chemical element that can exist by itself and retain the qualities that mark it as that element.

2. All material things in the universe known to our senses are composed of one or more CHEMICAL ELEMENTS.

3. Substances composed of more than one element are known as COMPOUNDS. Atoms of elements are held together in compounds by electrical forces in the outer parts of their structure.

4. The smallest theoretical unit of a compound, usually composed of two or more atoms, is known as a MOLECULE.

5. The smallest actual units of crystalline compounds found by use of microscopes and the electron microscope seem to be structures built up of the different atoms alternating in three-dimensional patterns to form the CRYSTAL LATTICE.

6. There were believed to be 92 CHEMICAL ELEMENTS, from hydrogen ($_1H^1$) the lightest to uranium ($_{92}U^{238}$) the heaviest, before the developments which led to utilization of atomic energy.

7. Two new elements, NEPTUNIUM ($_{93}Np^{237}$) and PLUTONIUM ($_{94}Pu^{239}$) were formed by neutron bombardment of Uranium 238.

8. Two additional new elements AMERICUM ($_{95}Am^{241}$) and CURIUM ($_{96}Cm^{242}$) have since been made by similar methods. More elements will follow.

9. When elements are represented, as above, by their chemical SYMBOLS, the subscript number is the atomic number. This is different for each element. The superscript number represents the atomic weight.

10. One of the qualities characteristic of matter is weight or mass. ATOMIC WEIGHT is expressed on a relative scale, as compared with the weight of hydrogen which is taken as one.

11. For convenience, the weights have been adjusted to make the atomic weight of the most abundant kind of oxygen 16.00. This shift makes most of the atomic weights nearly whole numbers, but changes that of HYDROGEN to 1.008. Physicists believe this fraction has significance for calculating the energy of nuclear reactions.

12. ATOMIC NUMBER is the measure of the electric charge on the nucleus of the atom. Atomic weight is the measure of the atom's mass.

13. Different samples of the same element, when tested by chemists, are sometimes found to have DIFFERENT ATOMIC WEIGHTS. Lead which occurs with radium, for example, has a different atomic weight from ordinary lead.

14. In all other ways the two kinds of lead are chemical twins, exactly alike except for weight. Elements which differ in weight only are called ISOTOPES.

15. Almost every element has been found to have a number of isotopes, some STABLE, some RADIOACTIVE. The atomic weight of the most stable isotope is generally used in listing the element.

16. Uranium has several isotopes. The usual kind, whose atomic weight is 238, was used to produce the new elements. U-235 was used to make the ATOMIC BOMB.

17. The isotope U-235 and the element plutonium can be used for bombs because they are capable of FISSION.

18. When fission occurs the nucleus of the atom SPLITS into two (occasionally more) lighter elements, with release of nuclear energy.

19. In some recent experiments with a high-powered cyclotron, even more thorough fragmentation of atomic nuclei resulted. This process, resulting in many light elements, was named SPALLATION.

20. Different elements, quite distinct in chemical behavior, may have isotopes of the same atomic weight. We have $_{92}$U-238, $_{93}$Np-238 and $_{94}$Pu-238, all with different properties. Such elements are called ISOBARS.

21. All atoms are believed to be composed of standard interchangeable parts. These are PROTONS, NEUTRONS and ELECTRONS.

22. Protons and neutrons make up the NUCLEUS of the atom. The structure of the atom is much like that of the solar system. The nucleus corresponds to the sun at the center. The planets are electrons.

23. The proton and the neutron each have a mass about equal to that of a hydrogen atom, which is 1 on the chemist's scale. Each is about 1800 times heavier than the electron. Particles called MESOTRONS or MESONS, intermediate in weight, are known, but their relationship to other atomic particles is as yet obscure.

24. The ELECTRONS, light in weight and some distance away from the heart or nucleus of the atom, revolve around the nucleus much as planets revolve around the sun. They are held in their courses by electric attraction.

25. The proton has a POSITIVE charge of electricity, the electron has a NEGATIVE charge equal and opposite to the positive charge of the proton. The neutron has no charge at all.

26. The difference in chemical properties of the elements is caused by difference in the number of protons in the nucleus. This is the ATOMIC NUMBER.

27. Chemical VALENCE, or combining power, is governed by the electrons in the outermost orbits of each atom.

28. Atomic weight is the SUM of the weights of the protons and neutrons in the nucleus.

29. It is the NEUTRON which figures in the transmutations which give atomic power. Neutrons can PENETRATE to the nucleus of heavy atoms when charged particles would be repelled by charges in the atom. The neutron is absorbed by the nucleus to form a heavier, unstable isotope of the element. This unstable isotope then decomposes radioactively, emitting an electron and changing to a new element one atomic number greater.

30. The HYDROGEN atom is believed to have just one proton as its nucleus, with one electron circling around it.

Hydrogen's atomic weight and atomic number are each one.

31. Hydrogen has an isotope which is just like ordinary hydrogen except that it is twice as heavy. It is known as "heavy hydrogen" and sometimes as DEUTERIUM (Symbol: D). Its compound with oxygen is called "heavy water."

32. The nucleus of HEAVY HYDROGEN contains one proton and one neutron. The atomic number of heavy hydrogen is one, corresponding to one proton. The atomic weight is two, corresponding to the two heavy particles, proton and neutron.

33. HELIUM has two protons and two neutrons in its nucleus. The two protons correspond to helium's atomic number two. The combined weights of protons and neutrons in the nucleus give helium its atomic weight 4. Two electrons, held in their orbits by the two protons, revolve around the nucleus.

34. The VOLUME of an atom is determined by the orbits of its outermost revolving electrons. Only a small fraction of the size of an atom is actually occupied by the protons, neutrons and electrons, just as the space occupied by the sun, the earth and other planets is only a small part of our solar system.

35. In spite of all the unoccupied SPACE, an atom is quite IMPENETRABLE to other atoms and to larger bodies. The electrons revolve millions of times a second, and keep everything out of the space within quite as effectively as though they were everywhere at once.

36. The only things than can get inside an atom are smaller things, FRAGMENTS of other atoms, protons, neutrons or electrons. They must be shot with just the right speed. These fragments of atoms are observed as radiations given off by radio-active elements.

37. RADIATION is wave motion, known to us as the electro-magnetic waves used for radio transmission, heat, light, X-rays and cosmic rays. Large numbers of extremely tiny particles in motion together act like waves.

38. Three types of rays are given off by radio-active substances. ALPHA particles are high-speed nuclei of helium atoms. BETA particles are high-speed electrons. GAMMA rays are electromagnetic radiations similar to X-rays and light.

39. Of these, only the gamma rays are properly called radiations, and even these act very much like particles because of their short wave-length. Such a "particle" or quantum of gamma radiation is called a PHOTON.

40. Because their radiation is emitted as photons, the SPECTRA of elements are seen as bands of colored light, not as a continuous series of wave lengths. Such bands are found also beyond the limits of visible light, but can be detected by photography.

41. Electrons in beta rays may be bent out of their straight-line paths by the influence of a magnet. This principle is used in the construction of the CYCLOTRON.

42. POSITRONS are like electrons, but are bent toward the opposite pole of the magnet because their charges are + instead of —.

43. The kind of rays emitted and the HALF LIFE (the time in which half the radioactivity decays) is a constant characteristic of each radioactive iso-

tope of every element, and is used to identify that isotope.

44. In general, the gamma rays are very penetrating, the alpha and beta rays less so. Even though the alpha and beta rays are not very penetrating, they have enormous SPEED.

45. The speed with which atom particles travel is the source of atomic energy. ENERGY is capacity to do work. It is work stored up for future use.

46. If you raise a weight to a height above the ground and suspend it there by some device, the WORK you put into raising it can be stored there indefinitely as POTENTIAL ENERGY. It will be there, ready, whenever you decide to release it.

47. The energy which a moving body has because it is in motion is called KINETIC ENERGY. The kinetic energy of any particle depends upon its mass and the square of its velocity. Energy is conserved by the moving particle until it strikes an object, then work is done.

48. All ENERGY is either potential or kinetic. Either one can be converted into the other. These two conversions are continually occurring.

49. Particles of atomic size have kinetic energy arising from several different kinds of MOTION. All atoms are constantly in motion.

50. If the atoms are so dispersed that the material constituting them is a GAS, that gas will exert pressure on all sides of the container that holds it, on account of the motion of the gas molecules.

51. Atoms which compose an element that will combine readily with another element, as hydrogen or carbon will combine with oxygen, have unsymmetrical arrangements of the outer electrons in their systems. These unsymmetrical arrangements tend to set up a sort of strain, which causes CHEMICAL COMBINATION to take place when elements with suitable combining powers are brought together.

52. These unsymmetrical arrangements give rise to FORCES which result in kinetic energy. This energy appears, for example, when carbon and oxygen burn to carbon dioxide, giving off heat, or hydrogen and oxygen explode to form water, again giving off heat.

53. Chemicals combining to form stable compounds give off energy in the process. These are known as EXOTHERMIC REACTIONS. Combinations which absorb energy, forming unstable compounds, are known as ENDOTHERMIC REACTIONS. Explosives, for example, which are highly unstable, are formed by endothermic reactions.

54. Chemical forces, electricity and heat are all forms of energy. Potential and kinetic energy may be distinguished in each case.

55. These energies all arise from motion of the atom as a whole, or motion resulting from attractions and repulsions between the outer PLANETARY ELECTRONS of the atom's structure.

56. Energy resulting from motion of particles deep within the structure of the atom was unknown until the discovery of RADIO-ACTIVITY.

57. Radioactive elements undergo SPONTANEOUS breaking up of their atoms, giving off alpha and beta particles and gamma rays. Loss of these particles causes the radio-active elements to change into other elements.

58. The energies shown in these TRANSMUTATIONS are thousands of

times greater than the kinetic energies which the molecules of a gas have by reason of their motion when heated. They are thousands of times greater than the energy changes per atom in chemical reactions.

59. The property of matter that connects it with motion is INERTIA. Inertia is opposition to change of motion.

60. One conclusion that appeared early in the development of the theory of RELATIVITY is that the mass due to inertia of a moving body increases as its speed is increased.

61. This increase implies an equivalence between an increase in energy of motion of a body (kinetic energy) and an increase in its MASS.

62. It is for this reason that Einstein suggested that studies of radioactivity might show the EQUIVALENCE of mass and energy.

63. Einstein's statement is that the amount of energy, E, equivalent to a mass, m, is given by the equation $E = mc^2$ where c is the VELOCITY OF LIGHT.

64. From this equation, one kilogram (2.2 pounds) of matter, if converted ENTIRELY into energy, would give 25 billion kilowatt hours of energy. This is equal to the energy that would be generated by the total electric power industry in the United States running for approximately two months.

65. Compare this fantastic figure with the 8.5 kilowatt hours of heat energy which may be produced by BURNING an equal amount of coal.

66. Until the atomic power research program, no instance was known of matter being converted into energy without more energy being used to produce the transformation than was released by it.

67. Two axioms of physics state: (1) MATTER can be neither created nor destroyed; (2) ENERGY can be neither created nor destroyed. For all practical purposes they were true and separate principles until about 1940.

68. It is now known that they are, in fact, two phases of a single principle, for we have discovered that energy may sometimes be CONVERTED into matter and matter into energy.

69. Such conversion is observed in the phenomenon of nuclear FISSION, a process in which atomic nuclei split into fragments with the release of an enormous amount of energy.

70. The extreme size of the CONVERSION FACTOR explains why the equivalence of mass and energy is never observed in ordinary chemical combustion.

71. We now believe that the heat given off in such COMBUSTION has mass associated with it, but this mass is so small that it cannot be detected by the most sensitive balances available.

72. Transformation of matter into energy is an entirely different sort of phenomenon than the usual chemical transformations, where the matter is changed into a different form but its MASS persists.

73. From the standpoint of the Laws of the Conservation of Matter and of Energy alone, transformation of matter into energy results in the DESTRUCTION of matter and CREATION of energy.

74. The OPPOSITE transformation, which astronomers believe may be going on in some of the stars, amounts to the destruction of ENERGY and the creation of MATTER.

Tough, Versatile Plastic Forms Products Other Than Hosiery

Multiple Uses For Many Nylons

by MARTHA G. MORROW

➤ NYLON, famous as the glamour thread that makes stockings more sheer than silk, is proving itself a tough plastic adapted to many new uses. Don't be surprised if you find:

Golf club heads with a nylon protective coating.

Gears and bearings of nylon in adding machines and electric shavers.

Wrist watches with straps made of it.

Nylon heads on soft impact hammers used in metal work.

Harps and guitars strung with nylon.

The fiber is proving its versatility by acquiring wool-like qualities. Thick, serviceable rugs are made of nylon, as are warm, quick-drying men's socks and soft, woolly sweaters. Felt, velvet and upholstery fabrics can be made entirely of nylon, or of nylon in combination with other fibers.

These new textiles are possible because nylon is being produced in short lengths. The continuous filament is given a permanent wave, then cut into lengths of a few inches so it can be handled like wool or cotton.

The name nylon is a generic term used to designate not one compound but a whole family of related compounds. These nylons are similar in chemical structure, but may be made in different degrees of toughness, hardness, flexibility and color. The formula used to produce dull nylon yarn, for example, is different from that used in making nylon for plastic cups and faucet washers.

A nylon molecule contains atoms of hydrogen, nitrogen, oxygen and carbon. One important type of nylon is made by the union of two chemical compounds with the involved names of hexamethylene diamine and adipic acid.

The diamine is made from coal (coke), air and water; from cyclohexane, a petroleum product; or from furfural, which comes from such farm by-products as corncobs and oat hulls. Adipic acid is made either from coke, air and water, or from petroleum.

The du Pont company neither makes stockings nor forms plastic articles. They manufacture nylon yarn for stockings and the material from which plastic fabricators make such things as nylon combs and gaskets. Each pair of stockings, for instance, contains only about 10 cents worth of nylon.

Nylon salt, the starting point for either hosiery or plastics, is dissolved in water to make it easier to ship. Upon reaching the spinning plant, the solution is heated to evaporate the water. When a certain concentration is reached, it is heated in an autoclave, a kind of giant pressure cooker. Here heat links the relatively small nylon salt molecules into giant ones.

This process, carefully controlled as to temperature and duration, gives nylon a molecular structure somewhat similar to wool and silk.

The hot, syrupy nylon is next allowed to flow out onto the broad rim of a large, slowly revolving wheel.

➤ NYLON FLAKES *going into the hopper will be melted, then squirted out as filaments whose diameter will depend upon the use to which they are to be put. Nylon is the general name for a class of products.*

Here a shower of water cools and hardens the nylon. The white ribbon is dried and chopped into flakes.

If the nylon is to become yarn, the translucent flakes from various batches are blended and melted. The liquid nylon is pumped out through tiny holes in a spinneret, a metal disc about the size of a silver dollar and as thick. To insure a filament of even diameter, the molten nylon is made to flow uniformly. Through each of these holes comes thousands of feet of thread each minute.

If the material is destined to be molded like a plastic, the ivory flakes are thoroughly dried and ground up into nylon molding powder compounds. The formula may be varied slightly, depending upon the finished article.

Nylon is a thermoplastic, so can be reheated and reshaped a number of times. It does not soften until the temperature goes much higher than that at which other thermoplastics soften—well above 300 degrees Fahrenheit.

The finished article, on the other

hand, can hold its shape at relatively high temperatures. Drinking glasses and nursing bottle funnels of nylon can be sterilized by steam without harm.

Melted nylon flows about as readily as light lubricating oil. Being so fluid, the plastic can be molded satisfactorily into articles of complicated shape and delicate structure. Nylon insulated wire played an important part during the war in keeping communications open on battle fields.

Sheets of the plastic, useful in machining a small number of pieces, can be made either by squirting out liquid nylon in sheet form or by slicing pieces of the required thickness from a nylon block. Strips of this sheet, like the yarn, can be stretched to several times their original length. Rods of various diameters permit samples for new applications to be machined and tested prior to the purchase of expensive molding equipment.

Bristles for brushes are made from thick strands of nylon. For hairbrushes and toothbrushes, the nylon bristle is of uniform diameter. A large number of long strands, tied together, are cut simultaneously into short lengths. Bundles of these are later fed into automatic machines that give tooth and hair brushes their bristles.

Bristles for paint brushes are more difficult to make. They must be tapered so the brush will flex properly and spread the paint well. Molten strands of nylon, coming from a spinneret with fairly large holes, are pulled away at a carefully controlled varying rate. By pulling now faster, now slower, the diameter of the strand is alternately decreased and increased.

Nylon textiles being made today in continuous forms include both the single or monofilament strand and a number of strands twisted together, called multifilament.

Multifilament yarns are made in both standard and high strength. They range in size from 20 to 210 denier (450 meters of one-denier yarn by definition weighs five centigrams). Single filament yarns are made in 15 denier and, for super-sheer stockings, have been produced experimentally as fine as 10 denier.

Only within the last year has nylon become available in cut-to-length, staple form. After being drawn to several times their original length to orient the molecular structure and increase the strength and elasticity, the strands are crimped by moist heat and pressure, and cut into short pieces, called staple. Thus nylon can be used in combination with other short fibers. When used alone, in the form of staple, it produces a thick, wool-like fabric.

Filament deniers of nylon staple range from 1½ to 15. A 15-denier yarn is about three times as fine as a human hair and contains approximately 300,000 yards of yarn to the pound.

Stockings and socks regain their original shape when washed because they have been permanently "set" with steam or very hot water. Once given a desired shape or form, they hold this shape permanently. But at a later date a different shape can be given the fabric, if desired, by heat-treating it to a higher temperature than used previously.

Nylon was first introduced to the public less than 10 years ago. Twenty years ago the late Dr. W. E. Carothers,

➤ BRISTLES FOR BRUSHES *will be the final form of these hanks of nylon. The exact formula of a nylon is chosen according to the properties needed.*

its discoverer, little dreamed that his research would lead to a material versatile enough to be used both as a plastic and as a synthetic textile fiber.

Nylon made its first public appearance as a toothbrush bristle. It established its popularity as yarn for sheer, quick-drying stockings. During the war it was so much in demand for military use that for more than three years no nylon was available commercially, except possibly in toothbrush bristles.

Today nylon is used in tire cord and laundry nets, garden hose and work gloves, sailcloths and trolley cords. It is beginning to appear in self-locking nuts and hypodermic needles, in phonograph needles and lawn sprinklers. Still very much an experimental product, the range of nylon's usefulness is just beginning to be explored.

A few sets of Things of Science popular Nylon Unit are still available. While they last, they may be ordered at fifty cents each postpaid, from Science Service, 1719 N St. N.W., Washington 6, D.C.

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